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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 36073, 36092, 36108, 36152, 36278, 36324, 36327, 36359, 36431, 36455, 36587, and 38151.

35833 (AAEC/TM-372) THE DETECTION AND ESTIMATION OF ^{114m}In IN EFFLUENT. Porritt, R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Feb. 1967. 14p. Dep.

A simple method for the quantitative determination of indium-114m in effluent is described. Five litres of effluent are scavenged with ferric hydroxide and the indium-114m determined by gamma spectrometry. The method is rapid, economical of operator time, and is applicable down to concentrations of 2×10^{-4} μCi/l and lower. (auth)

35834 (BARC-277) VACUUM FUSION TECHNIQUE FOR GASES IN METALS. Krishnamoorthy, T. S.; Krishnan, C. V.; Venkateswarlu, Ch. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 20p. Dep.

A vacuum-fusion apparatus for determination of gases in metals and alloys is described. Some salient points from experience in setting up and working with this technique for the last years are recorded. (auth)

35835 (BARC-280) USE OF REACTOR FAST NEUTRONS IN THE ANALYSIS OF FLUORINE. Reddy, G. R.; Sankar Das, M. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 10p.

Utilization of fast neutrons for the activation-analysis determination of fluorine by the $^{19}F(n,2n)^{18}F$ reaction is described. The average cross section for this reaction in a spectrum of fission neutrons was determined using $^{58}Ni(n,p)^{58}Co$ as a monitor for flux measurements. Application of the reaction was demonstrated by analyzing teflon samples for their fluorine content. The practical sensitivity of the method is 500 μg of fluorine under the experimental conditions. (auth)

35836 (BARC-283) SPECTROGRAPHIC DETERMINATION OF RARE EARTHS IN SODIUM CHLORIDE. Krishnan, T. S.; Kartha, V. B.; Patel, N. D.; Gopal, Sheila (Bhabha Atomic Research Centre, Bombay (India)). 1967. 5p.

A spectrographic method for determination of 0.05 to 2 ppM of rare earths impurities in sodium chloride is described. The method involves chemical pre-concentration of the rare earths as fluorides using lanthanum fluoride as a carrier and excitation of the spectra using a spark source. The standard deviation for the spectrographic estimation is of the order of ±9% whereas that for the complete determination including chemical pre-concentration, is of the order of ±15% at the 0.5 ppM level. (auth)

35837 (BARC-284) A SPECTROGRAPHIC METHOD FOR THE ANALYSIS OF IMPURITIES IN SODIUM CHLORIDE. Kartha, V. B.; Krishnan, T. S.; Patel, N. D.; Gopal, Sheila (Bhabha Atomic Research Centre, Bombay (India)). 1967. 9p.

A spectrographic method for determination of trace impurities in sodium chloride is described. The elements Cu, Co, Bi, Au, In, Ni, Pb, Pd, Tl, Cd, and Hg are concentrated by extraction with chloroform from a buffered solution of sodium chloride, using sodium diethyl dithiocarbamate (DDTC) as complexing agent. The chloroform extract is evaporated on graphite and determined spectrographically with barium fluoride as carrier. The impurities can be determined in the 0.5 to 50 ppM range in a graphite matrix with a standard deviation of about ±8% at the 20 ppM level. The method is applicable to other elements that can be separated by suitable complexing agents. (auth)

35838 (BNWL-478) HIGH EXPOSURE PLUTONIUM STUDIES: ANALYSES OF SHIPPINGPORT FUEL. Smith, R. C.; Van Tuyl, H. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.) July 1967. Contract AT(45-1)-1830. 15p. Dep. CFSTI.

Detailed analyses on seven samples of Shippingport blanket fuel are presented. The plutonium and uranium isotopic distributions are given for Shippingport blanket fuels varying in estimated exposure from approximately 10,000 to 30,000 MWd/t. Calculated amounts of the uranium and plutonium isotopes and several other heavy nuclides of potential commercial use are also presented. These data are presented as a part of a long-range study to learn the isotopic distribution and radiation exposures to be expected from high-exposure plutonium recycled from power reactor fuels. The data fall into consistent patterns. Fuel burnup as calculated from the measured amounts of the various nuclides is compared to ^{137}Cs and ^{148}Nd burnup calculations. Some of the first preliminary dosimetry data from the high exposure plutonium are also included. (auth)

35839 (BNWL-SA-1022) MEASUREMENT OF THE PHOTON TO ALPHA RATIO FOR PLUTONIUM ISOTOPES. Swinth, K. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 5, 1967. Contract AT(45-1)-1830. 23p. (CONF-670714-2). Dep. CFSTI.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio.

Techniques were developed for measurement of the x-ray to alpha yield ratio of plutonium in order to compare sources and to evaluate the radiological hazard and isotopic composition of plutonium sources. A proportional counter–scintillation counter combination was selected for the measurements and calibration was accomplished using an ^{241}Am source. Data are presented in graphs. (M.C.G.)

35840 (DP-1115) PRECISE DETERMINATION OF OXYGEN IN REFRACTORY OXIDES BY INERT GAS FUSION-GAS CHROMATOGRAPHY. Doherty, P. E. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). July 1967. Contract AT(07-2)-1. 11p. Dep. CFSTI.

A commercial instrument employing inert gas fusion-gas chromatography has been modified to quantitatively determine the oxygen content of actinide oxides and other refractory oxides. The instrument gives a relative precision of 0.4% for samples containing 0.5 to 7.0 mg of oxygen. The method requires 12 minutes per determination, permits flexibility in the choice of sample size, and requires only a single daily analysis to ensure that the calibration curve is satisfactory. (auth)

35841 (EUR-3466,d) AUSARBEITUNG UND NACHARBEITUNG SOWIE STANDARDISIERUNG VON ANALYTISCHEN VERFAHREN ZUR BESTIMMUNG DER POLYPHENYLE UND EINIGE IHRER ORGANISCHEN BZW. ANORGANISCHEN VERUNREINIGUNGEN. Jahresbericht 15.2.1965–15.2.1966. (Devising, Revising, and Standardizing Analytical Processes for Determining Polyphenyls and Some of Their Organic or Inorganic Impurities. Annual Report, February 15, 1965–February 15, 1966). (Farbenfabriken Bayer A.G., Leverkusen (West Germany). Organisch Analytisches Laboratorium). June 1967. 15p. (In German). Dep.

Analytical procedures for determining polyphenyls and their organic or inorganic impurities are being revised and standardized. Procedures for determining the following components were studied: ash, iron, sulfur, chlorine, oxygen, boron, and high-boilers. Special mention should be made of tracer acid deter-

mination by Unterzaucher's method. Critical comparison of the various methods enabled the following points to be determined: the advantages and disadvantages of a given method; what improvements must be effected in order to obtain the optimum analytical estimate of the substances to be tested; and the sensitivities, determination limits, and standard deviations of the various methods. Clear instructions were drawn up, which can be applied even by laboratories that do not specialize in the analysis of polyphenyls. (auth)

35842 (EUR-3480.f(Vol.2)) METHODES ANALYTIQUES MISES AU POINT DANS LE CADRE DE LA RECUPERATION DES PRODUITS DE FISSION. DEUXIEME PARTIE: ANALYSES APPLIQUEES AU PROCEDE DE SEPARATION DU ^{137}Cs. (Analytical Methods Developed in the Course of Fission Product Recovery. Part II. Analyses Applied to the ^{137}Cs Separation Process). Azoeuf, P.; Guillon, A.; Lefevre, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). June 1967. Contract 025-62-10 RISF. 44p. (In French). Dep.

The first set of methods for separating cesium-137 by ion exchange concerns the analysis of mineral ion exchangers. Only chemical methods allow assaying all the constituents of the resins considered. The difficulties they involve lead to their rejection if a large number of assays have to be made. The x-ray-fluorescence method, though it may produce less information, permits quick, accurate assaying of the major constituents (W and Zr). These data are often sufficient. The validity of the method was ascertained by checking with neutron activation analysis. The second set concerns the methods used to check the functioning of an inactive cesium-extraction pilot plant. They comprise cesium assays by atomic absorption spectrophotometry and potentiometry assays of acidity and of nitrogen compounds. (auth)

35843 (IAERU-6608) SEPARATION OF RECOILING CHROMIUM(II) SPECIES FROM NEUTRON-IRRADIATED HEXAQUOCHROMIUM(III) ION ADSORBED ON ION-EXCHANGER. Matsuura, Tatsuo; Sasaki, Takashi (Rikkyo Univ., Yokosuka (Japan). Inst. for Atomic Energy). [1966]. 19p. Dep.

Since it has been reported that chromous ion is produced as a main recoil product in the neutron-irradiated chromic compound, the dynamic extraction of the ^{51}Cr-enriched chromous species during irradiation of hexaquochromium ion adsorbed on a cation exchange resin was carried out using oxalic acid as the eluent. The dynamic method gave a higher yield and enrichment factor than the static irradiation method. The dynamic irradiation at constant temperature was also performed for the first time and the effects of the irradiation temperature and of bead radius upon the separable yield and the enrichment factor were studied. The enrichment factor increased with decreasing irradiation temperature. The inherent yield which was estimated from the extrapolation to the zero bead radius increased with increasing irradiation temperature. The results were interpreted by the hypothesis that the thermodynamic equilibrium would be established at the end of the hot reaction in the recoil process. (auth)

35844 (IS-T-156) ACTIVATION ANALYSIS OF SOME TUNGSTEN BRONZES. Wechter, Margaret Ann (Ames Lab., Iowa). May 1967. Contract W-7405-eng-82. 79p. Dep. CFSTI.

Thesis.

Eight different elements in their tungsten bronzes, M_xWO_3 ($0 < x < 1$) were determined using activation methods with three different irradiation techniques. All analyses were nondestructive, requiring no radiochemical separations. Rb, Ho, La, and U were determined by thermal-neutron activation; Ba was determined using 14-MeV neutrons; and K, Gd, and Eu were determined using synchrotron bremsstrahlung to produce the reactions. Accuracy of all methods was established by analyzing samples of known composition, prepared with a calculated metal-to-tungsten ratio. Results from the analyses of cubic U_xWO_3 and Gd_xWO were plotted against their lattice parameters and compared to similar graphs for Na_xWO_3 and Li_xWO_3. All these graphs when extrapolated to x = 0 shared a common intercept, indicating the existence of a relation between lattice parameter and x-value common to all cubic tungsten bronzes. (P.C.S.)

35845 (K-1699) THE TUNGSTEN HEXAFLUORIDE–HYDROGEN FLUORIDE TRIPLE POINT CURVE AND ITS APPLICATION TO A METHOD OF ANALYSIS. Hedge, W. D. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Aug. 17, 1967. Contract W-7405-eng-26. 22p. Dep. CFSTI.

The triple-point curve for the binary system tungsten hexafluoride–hydrogen fluoride was determined over the range of 0.0 to 6.0 mole % hydrogen fluoride. This system is represented by the following equation: mole fraction $HF = (\Delta t)^2 e^{-3.65}$, where Δt is the depression of the triple point of pure tungsten hexafluoride in degrees centigrade. A method is presented for correcting the deviations resulting from nonideality of the binary system. Extensions of the observed triple-point depressions of different ratios of liquid volume to total volume are represented by the following equation: mole fraction $HF = (\Delta t)^2 \exp(-4.15 + 1.11R - 0.61R^2)$, where Δt is defined above and R is the ratio of liquid volume to total volume. (auth)

35846 (KAPL-M-6702(Rev.)) LSBR/LWB DEVELOPMENT PROGRAM: THE SPECTROGRAPHIC ANALYSIS OF THORIA. DelGrosso, D. A.; Landis, F. P. (Knolls Atomic Power Lab., Schenectady, N. Y.). May 1967. Contract W-31-109-eng-52. 30p. (KAPL-A-SM-20(Rev.)). Dep. CFSTI.

Several emission spectrographic analytical procedures were developed for determination of 32 trace impurity elements in thorium dioxide. For determination of the more volatile impurities, three silver chloride carrier distillation procedures are described. To achieve optimum sensitivity for the detection of other impurity oxides, three buffered burn procedures are used. Finally, ion-exchange separation and chemical-carrier concentration of rare earth elements are described, together with the spectrographic procedure for their determination. For most impurity elements, detection sensitivities are in the low ppM range and analytical precisions are 10 to 20% relative. (auth)

35847 (LA-3711) SPECTROPHOTOMETRIC MEASUREMENT OF RHENIUM IN PLUTONIUM–RHENIUM ALLOYS. Dahlby, J. W.; Waterbury, G. R. (Los Alamos Scientific Lab., N. Mex.). Mar. 31, 1967. Contract W-7405-eng-36. 10p. Dep. CFSTI.

Microgram quantities of rhenium in 100-mg samples of plutonium–rhenium alloys were measured spectrophotometrically as the furil dioxime complex following separation from plutonium by a double-distillation from sulfuric–hydrochloric acid solution. Furil dioxime, acetone, and stannous chloride are added to the distillate to form the colored complex, and the absorbance is measured at a wavelength of 532 mμ. The measured molar absorptivity of the complex is 40,100. Based upon a total of 42 determinations of 13.4, 134.4, and 201.6 μg. (134 ppM, 0.1344%, and 0.2016%) of rhenium in 100-mg samples, relative standard deviations of 1.4, 0.34, and 0.47%, respectively, were obtained. The method was applied successfully to measurement of rhenium concentrations as high as 8%. Of 35 ions investigated, Cu^{2+}, Ga^{3+}, Hg^{2+}, Mo^{6+}, NO_3^-, Pd^{2+}, Pt^{4+}, Ru^{2+}, Sb^{3+}, and Ta^{5+} caused an interference of greater than 2% when present in 50-mg quantities. (auth)

35848 (LA-DC-8784) MEASUREMENT OF THE SURFACE DISTRIBUTION OF CARBON AND OXYGEN BY ^3He ACTIVATION AND AUTORADIOGRAPHY. Holm, Dale M.; Sanders, W. Mort; Briscoe, William L.; Parker, Jack L. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 15p. (CONF-670714-3). Dep. CFSTI.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio.

Activation of oxygen and carbon by ^3He is a very sensitive method for determining trace amounts of these elements in matrices of high atomic number. The reaction products of $^{16}O(^3He,p)^{18}F$ and $^{12}C(^3He,^4He)^{11}C$ have convenient half-lives of 110 min and 20.4 min, respectively, and are positron emitters. The positron annihilation radiations were recorded with a coincidence counting system and a multiscaler analyzer. The composite decay curve was unfolded into its component parts with a computer to determine the amounts of carbon and oxygen on the activated surface. Autoradiographs of the activated surface were made with nuclear emulsion track plates. The duration of the autoradiographic exposures was determined with a calibrated exposure-meter-scaler. Thus, a sequence of pictures was made and the isotopes that caused the exposure were identified from the unfolded decay curve. Samples of germanium, tantalum, zirconium, steel, nickel, and stainless steel were irradiated, and segregation of oxygen or carbon was frequently observed as small spots or along grain boundaries. While the method is primarily applicable to the measurement of surface distributions, it is possible to measure deeper into the sample by grinding or etching after irradiation. The autoradiographic method is particularly useful in samples with nonuniform distributions of oxygen and carbon having average concentrations of about 100 ppM. Concentrations of carbon along adjacent grain boundaries separated by 0.0005 in. were observed. (auth)

35849 (NP-16904) REFERENCE METHODS FOR REFRACTORY METALS ANALYSIS. Miller, G. L. (ed.) (Advisory Group for Aerospace Research and Development, Paris (France)). 1966. 57p. CFSTI.

Methods are described for the determination of C, H, Fe, N, and O in Mo, Nb, Ta, and W. The methods were established by the collaborative effort of several international laboratories with special experience in refractory metal analysis. (P.C.H.)

35850 (NUMEC-3292-5) ISOTOPIC ANALYSIS OF BORON BY OPTICAL EMISSION SPECTROSCOPY. Shuster, E. E.; Zabron, F. S. (Nuclear Materials and Equipment Corp., Lewiston,

N. Y. Niagara Div.). June 28, 1967. Contract AT(40-1)-3292. 16p. Dep. CFSTI.

A quantitative spectrochemical procedure for determining the relative abundances of ^{10}B and ^{11}B in boron and its compounds is described. The method is applicable to all isotopic ratios using equipment normally found in or readily available to an industrial spectrochemical laboratory. A solution of the sample is aspirated into a helium-stabilized arc discharge (plasma jet) in which the ^{10}B and ^{11}B emission lines at 3451 Angstroms are excited. The spectra are photographically recorded at high dispersion. From the intensity ratio of the two lines, a relative abundance is determined. (auth)

35851 (RFP-978) CALCIUM–LEAD ALLOY ANALYSIS BY ATOMIC ABSORPTION AND EMISSION SPECTROSCOPY. Barton, Harlan N.; Johnson, Andrew J.; Shepherd, Glenn A. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Aug. 9, 1967. Contract AT(29-1)-1106. 8p. Dep. CFSTI.

Analysis of a calcium–lead alloy by atomic absorption spectrometry and emission spectrography is described. Calcium in the 0.04 to 0.10% range is determined by an atomic absorption method. Samples are dissolved in nitric acid, lanthanum added to eliminate possible interferences, and the samples aspirated into an acetylene air flame. Recoveries on 11 synthetic samples averaged about 100%. The relative standard deviation on 11 aliquots of the same sample was 0.30% on a sample containing 640 ppM of calcium. A semiquantitative emission-spectrographic method is used for determination of 46 impurity elements. The alloy is converted to oxide, diluted with graphite, and excited by a dc arc. Spectra are recorded photographically and visually compared with standard spectra. (auth)

35852 (TRG-Report-1332) THE TEMPERATURE-GRADIENT TUBE TECHNIQUE FOR CHARACTERISATION OF RELEASED FISSION PRODUCTS. Collins, D. A.; Collins, R. D.; Taylor, R.; McIntosh, A. E.; Roys, W. B. (United Kingdom Atomic Energy Authority, Sellafield (England). Reactor Group). Jan. 20, 1967. 28p. Dep. CFSTI. UK 4s.

In principle, released fission products may be characterized according to their volatility by observing the temperature at which they deposit when passed through a tube along which temperature is uniformly reduced. A mathematical model to describe this process was developed, which correctly predicts the shape of the deposit and relates the temperature at which deposition starts to the vapor-pressure curve of the compound concerned. The adaptation of this technique as a sampling method for general use in fission product transport experiments was studied using cesium iodide as a typical fission product. Although under carefully controlled conditions behavior followed that predicted by the mathematical model, it was very susceptible to disturbing factors particularly at low mass levels of cesium iodide. Application to the study of fission products released from irradiated uranium dioxide in laboratory experiments gave results that proved impossible to interpret because of the low mass levels concerned. (auth)

35853 CHEMICO-SPECTRAL ANALYSIS FOR DETERMINING LANTHANUM, PRASEODYMIUM, AND NEODYMIUM IN PURE CERIUM DIOXIDE. Antonov, A. V.; Drygin, A. I.; Kalmykov, Yu. A. Zavod. Lab., 33: 967-70(1967). (In Russian).

The sensitivity of the spectral determination of La, Pr, and Nd in CeO_2 was improved by preliminary concentration of the impurities by extraction of the basic tetravalent cerium using bis(2-ethylhexyl) orthophosphate. The sensitivity of a direct determination of 0.005% La_2O_3, 0.03% Pr_6O_{11}, and 0.03% Nd_2O_3 by a chemical spectral method with the lowest enrichment coefficient (K = 15) was 0.0003% La_2O_3, 0.002% Pr_6O_{11}, and 0.002% Nd_2O_3. The variation coefficient calculated by the suggested method was 13% for the mean concentration of the impurities of 0.0030% (the results obtained for Pr_6O_{11}, <0.0015%, were not considered. (R.V.J.)

35854 ACTIVATION DETERMINATION OF IMPURITIES IN TRICHLOROMETHYLSILANE WITH EXTRACTIONAL SEPARATION OF THE ELEMENTS. Gil'bert, E. N.; Pronin, V. A.; Artyukhin, P. I.; Nikolaev, A. V. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Dokl. Akad. Nauk SSSR, 172: 853-5(1967). (In Russian).

A combined extraction–activation method was developed for the removal of impurity elements in trichloromethylsilane. The elements were separated in groups, determining the individual concentrations on the basis of γ spectra without any further separation, except in a few cases when the γ quantum energies of the radioisotopes were too close to each other. The irradiated sample was first dissolved, the gold, antimony, gallium, and iron were separated by solvent extraction. A second group consisting of zinc, cadmium, tungsten, rhenium, silver, platinum, palladium, and iridium, and a third one including indium, copper, tellurium, and tin were then removed separately by varying the solvent used for the extraction agent; this was followed by the removal of cobalt and selenium. Changing the agent, thallium was obtained. The aqueous phase contained potassium, sodium, cesium, arsenic, strontium, barium, chromium, manganese, and nickel, which could then be determined without any further separation, by γ spectrometry. The tests were carried out with rectified trichloromethylsilane. (TTT)

35855 DETERMINATION OF THORIUM IN URINE BY THERMAL-NEUTRON-ACTIVATION ANALYSIS. Twitty, B. L.; Boback, M. W. (National Lead Co. of Ohio, Cincinnati). Trans. Amer. Nucl. Soc., 10: 57-8(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35856 A DIRECT NAA METHOD FOR DETERMINATION OF GOLD IN SERUM AND URINE SPECIMENS OF PATIENTS WITH RHEUMATOID ARTHRITIS. Babb, A. L. (Univ. of Washington, Seattle); Woodruff, G. L.; Miller, W. P.; Wilson, W. E. Jr.; Polinsky, P. D.; Decker, J. L. Trans. Amer. Nucl. Soc., 10: 58(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35857 SOLVENT EXTRACTION AND DETERMINATION OF MAGNESIUM IN BIOLOGICAL MATERIALS: COMPARATIVE ANALYSIS BY NEUTRON ACTIVATION, ATOMIC ABSORPTION SPECTROPHOTOMETRIC, AND FLUOROMETRIC TECHNIQUES. Hahn, Kwang J.; Tuma, Dean J.; Quaife, Merton A. (Veterans Administration Hospital, Omaha, Neb.). Trans. Amer. Nucl. Soc., 10: 62(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35858 NUCLEAR METHODS FOR THE STUDY OF ZINC METABOLISM. Strain, William H. (Univ. of Rochester, N. Y.). Rob, Charles G.; Pories, Walter J.; Hennessen, John A.; Montoya, John; Barker, Wesley; Haskins, John. Trans. Amer. Nucl. Soc., 10: 60-1(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35859 NONDIALYZABLE MANGANESE AND COPPER IN HUMAN BILE. Miller, E. B.; Kanabrocki, E. L.; Case, L. F.; Graham, L.; Fields, T.; Oester, Y. T.; Kaplan, E. (Veterans Administration, Hines, Ill.). Trans. Amer. Nucl. Soc., 10: 61(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35860 NEUTRON ACTIVATION ANALYSIS OF TRACE IMPURITIES IN SILICO-CHLOROFORM. Rausch, Henrik; Csada, Imrene; Szabo, Elek. KFKI (Kozp. Fiz. Kut. Int.) Kozlem., 15: 229-37(1967). (In Hungarian).

A method developed for the neutron activation analysis of trace contaminants in silico–chloro derivates ($SiHCl_3$, $SiCl_4$), used for the production of silicon semiconductors, is described. Both chemical separation and nondestructive (γ-spectrometry and coincidence counting) techniques are used. Cu, As, Sb, and P can be separated by fast extraction. The method proved satisfactory for pure silicochloro- as well as for samples enriched with triphenyl chloromethane. (auth)

35861 PHOTONUCLEAR ACTIVATION ANALYSIS OF GEOLOGIC SAMPLES USING THE LINAC. Guinn, V. P.; Andersen, G. H. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 23-4(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35862 LOW-LEVEL COUNTING APPLICATIONS TO METEORITE ANALYSIS. Schmitt, R. A. (Oregon State Univ., Corvallis). Trans. Amer. Nucl. Soc., 10: 24-5(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35863 DETERMINATION OF VANADIUM IN COLORADO RIVER WATERS. Linstedt, K. D.; Kruger, Paul (Stanford Univ., Calif.). Trans. Amer. Nucl. Soc., 10: 20(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35864 THE APPLICATION OF LITHIUM-DRIFTED GERMANIUM DETECTORS TO NEUTRON-ACTIVATION ANALYSIS: NONDESTRUCTIVE DETERMINATION OF Re AND Eu IN ORES. Graber, F. M.; Lukens, H. R.; MacKenzie, J. K. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 26(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35865 HIGH-PRECISION DETERMINATION OF SILICON IN GEOLOGICAL SAMPLES BY FAST-NEUTRON-ACTIVATION ANALYSIS. Vincent, H. A.; Volborth, Alex (Univ. of Nevada, Reno). Trans. Amer. Nucl. Soc., 10: 26 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35866 COMPOSITIONAL ANALYSIS OF LUNAR AND PLANETARY SURFACES WITH PULSED 14-MeV NEUTRON-PRODUCED THERMAL-NEUTRON CAPTURE GAMMA RAYS. Reed, J. H.; Mandler, J. W.; Terrell, C. W. (Illinois Inst. of Tech., Chicago). Trans. Amer. Nucl. Soc., 10: 27 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35867 ACCURATE DETERMINATION OF TOTAL OXYGEN IN SIX NEW US GEOLOGICAL SURVEY ROCK STANDARDS BY FAST-NEUTRON ACTIVATION. Volborth, Alex; Vincent, H. A. (Univ. of Nevada, Reno). Trans. Amer. Nucl. Soc., 10: 27-8 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35868 ELEMENTAL ANALYSIS USING THE NEUTRON-CAPTURE GAMMA-RAY TECHNIQUE WITH A Ge(Li) DETECTOR. Greenwood, R. C. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc., 10: 28-9 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35869 PROMPT ACTIVATION ANALYSIS OF COAL USING NEUTRON-CAPTURE GAMMA RAYS. Rasmussen, N. C.; Hukai, Y. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 10: 29-30 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35870 UTILIZATION OF HIGH-YIELD AMERICIUM–BERYLLIUM–CURIUM NEUTRON SOURCES FOR IN SITU ELEMENTAL ANALYSIS. Mandler, J. W.; Terrell, C. W. (Illinois Inst. or Tech., Chicago). Trans. Amer. Nucl. Soc., 10: 30 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35871 SIMULATED NEUTRON-ACTIVATION SPECTRA FOR GEOCHEMICAL ANALYSIS. Charyulu, V. (Univ. of Tulsa, Okla.); Horn, M. K. Trans. Amer. Nucl. Soc., 10: 31 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35872 OPTIMIZATION OF CONFIGURATION FOR COMPOSITION ANALYSIS BY ALPHA-EXCITED X-RAY FLUORESCENCE. Sellers, Bach; Wilson, Henry H. (Parametrics, Inc., Waltham, Mass.). Trans. Amer. Nucl. Soc., 10: 31-2 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35873 INSTRUMENTAL DETERMINATION OF FLUORINE IN BIOLOGICAL MATRICES BY PHOTONUCLEAR ACTIVATION ANALYSIS. Andersen, G. H. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 63 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35874 ELEMENTAL ANALYSIS OF PROTEINS BY 14-MeV NEUTRON ACTIVATION. Crambes, M. (National Bureau of Standards, Washington, D. C.); Nargolwalla, S. S.; May, Leopold. Trans. Amer. Nucl. Soc., 10: 63-4 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35875 SURVEY OF CHROMATOGRAPHIC PAPERS FOR INTERFERING NUCLIDES IN ACTIVATION ANALYSIS. Smathers, James B. (Walter Reed Army Inst. of Research, Washington, D. C.); Duffey, Dick; Lakshmanan, Sitarana. Trans. Amer. Nucl. Soc., 10: 64-5 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35876 PRESENT STATUS OF HAIR CHARACTERIZATION STUDIES BY ACTIVATION ANALYSIS. Jervis, R. E. (Univ. of Toronto). Trans. Amer. Nucl. Soc., 10: 66 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35877 NEUTRON-ACTIVATION ANALYSIS OF BULLET LEAD. Lukens, H. R.; Guinn, V. P. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 66-7 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35878 ACTIVATION ANALYSIS OF GUNPOWDER RESIDUES CONTAINING RARE-EARTH TRACERS. Thomas, C. C. Jr. (Western New York Nuclear Research Center, Inc., Buffalo); Pillay, K. K. S.; Sondel, J. A.; Thomas, R. C. Trans. Amer. Nucl. Soc., 10: 67 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35879 UTILIZATION OF REACTOR PULSES AND SUB-SECOND HALF LIVES IN NEUTRON-ACTIVATION ANALYSIS. Lukens, H. R.; MacKenzie, J. K. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 85-6 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35880 DEUTERON-INDUCED PROMPT GAMMA-RAY ANALYSIS. England, L. D.; Ashe, J. B.; Williams, G. H.; Morgan, I. L.; Blake, K. R. (Texas Nuclear Corp., Austin). Trans. Amer. Nucl. Soc., 10: 86-7 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35881 SIMPLE METHOD TO CALCULATE SENSITIVITIES AND INTERFERENCES VS BOMBARDMENT ENERGY IN ^{3}He ACTIVATION ANALYSIS. Ricci, Enzo; Hahn, R. L. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 87-8 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35882 ELEMENTAL ANALYSIS BY PHOTONUCLEAR EXCITATION WITH 6- AND 8-MeV BREMSSTRAHLUNG. Lukens, H. R.; Graber, F. M.; Perry, K. I. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 90 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35883 FISSION-FRAGMENT AUTORADIOGRAPHIC TECHNIQUE FOR DETECTION OF ^{244}Cm. Mosley, W. C. Jr. (E. I. duPont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc., 10: 91-2 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35884 DETERMINATION OF IMPURITIES IN A SODIUM-SYSTEM COLD TRAP. Dutina, D. (General Electric Co., Pleasanton, Calif.); Simpson, J. L.; Young, R. S. Trans. Amer. Nucl. Soc., 10: 145 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35885 ACTIVATION ANALYSIS WITH SMOOTHED GAMMA-RAY SPECTRA. Yule, Herbert P. (Texas A and M Univ., College Station). Trans. Amer. Nucl. Soc., 10: 38 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35886 DETERMINATION OF POTASSIUM IN RUBIDIUM AND CESIUM SALTS BY ACTIVATION ANALYSIS. Bastian, J.; Lieser, K. H. (Technische Hochschule, Darmstadt, Ger.). Radiochim. Acta, 7: 152-3 (June 1967). (In German).

After neutron activation potassium was separated quantitatively from rubidium and cesium by using columns filled with titanium hexacyanoferrate(II). It was precipitated as potassium tetraphenylborate. (auth)

35887 EXTRACTIVE PHOTOMETRIC DETERMINATION OF SCANDIUM BY CHLORPHOSPHONAZO III. Fadeeva, V. I.; Kuchinskaya, O. I. Vestn. Mosk. Univ., Ser. II Khim., No. 1, 67-9 (Jan.-Feb. 1967). (In Russian).

Extraction of complex scandium compounds by chlorophosphonazo III in a form of ion associates of various organic cations was studied. Diphenylguanidine chloride, tetraphenylarsonium, and dioctylamine were used as organic cations. (R.V.J.)

35888 AN AUTOMATIC IRRADIATION AND MEASURING EQUIPMENT FOR RAPID ACTIVATION ANALYSIS WITH 14-MeV NEUTRONS. Braun, H.; Schulze, W. (Freie Univ., Berlin). Kerntechnik, 9: 289-93 (July 1967). (In German).

Irradiation and measuring equipment for investigation of activation analysis with 14-MeV neutrons is described. It is possible to carry out irradiations and measurements automatically by means of a pneumatic-tube establishment and a control system for rapid sample transportation in the activation-analysis laboratory. The neutron spectrum is calculated. The absolute neutron flux density is successfully determined by the activation method with the re-

action $^{16}O(n,p)^{16}N$. A cooling-water monitor serves for the relative flux-density determination. (auth)

35889 DETERMINATION OF RECOIL ATOMS OF ^{119m}Sn, STABILIZED AS METALLIC TIN IN TIN OXIDE IRRADIATED IN ATOMIC REACTOR. Nesmeyanov, A. N.; Babeshkin, A. M.; Efremov, E. N.; Bekker, A. A. Vestn. Mosk. Univ., Ser. II Khim., No. 1, 107-9(Jan.–Feb. 1967). (In Russian).

An amalgamation method was used for determining the content of metallic tin in tin oxides irradiated in a reactor. The results showed that the metallic tin content in irradiated tin oxide was 1.23% and in tin dioxide 0.30%; with corrections for the surface part the amounts were ~25 and 6%, respectively. Comparisons of the data obtained by a gravimetric and a radiochemical method indicated that in irradiated tin oxides the recoil atoms of tin-119m, appearing as metallic tin, are the products of tin oxide decomposition. (R.V.J.)

35890 MASKING OF ZIRCONIUM IN PHOTOMETRIC DETERMINATION OF THORIUM. Kuo, Hsiao-wei (Bureau of Metallurgical Industry, Shensi, China). Hua Hsueh Hsueh Pao, 26: 103-7(Apr. 1960). (In Chinese).

In the photometric determination of Th with thoronol, it was found that dehydroascorbic acid may be used as an effective masking reagent for Zr. The optimum conditions were investigated, and a procedure is given for the determination of Th in the presence of Zr. The method was used for the determination of Th in monazite sand and satisfactory results were obtained. (JPRS)

35891 SIMPLE SCINTILLATION PROBE FOR LIQUID SCINTILLATORS. Kokta, Ladislav (Inst. for Research, Production, and Application of Radioisotopes, Prague). Chem. Listy, 60: 1547-9(Nov. 1966). (In Czech).

A probe is described for the determination of ^{14}C, ^{35}S, and ^{3}H by liquid scintillation. Operating instructions are given. (JPRS)

35892 QUICK DETERMINATION OF CERIUM IN MANGANESE-CONTAINING MINERALS. Cheng, Ta-chung. Hua Hsueh Shih Chieh, No. 12, 573(Dec. 10, 1964). (In Chinese).

Serious interference from Mn occurs when the ammonium supersulfate or the sodium bismuthate method is used to determine Ce. A method for determining cerium without having to isolate manganese first is reported. (JPRS)

35893 STUDIES ON THE ANALYTICAL CHEMISTRY OF SCANDIUM. Ni, Che-ming; Kuznetsov, V. I.; Myasoedova, G. V.; Okhanova, L. A. (Inst. of Geology and Analytical Chemistry, Moscow). Hua Hsueh Hsueh Pao, 27: 74-85(Oct. 1961). (In Russian).

From solutions of pH ~ 1 containing even 0.5 μg Sc/l, Sc can be wholly separated by coprecipitation with the precipitate formed by Arsenazo I and methyl violet. At pH, Sc is wholly extracted with a solution of 5,7-dinitro-8-quinolinol in cyclohexanone; 8-quinolinol extracts Sc much less completely. Using Arsenazo III in a 10 ml volume, 5 to 30 μg Sc can be determined photometrically in the presence of Yb and several other elements. By titrating with EDTA at pH 1.1 with methyl violet indicator, Arsenazo III can be used to determine 2 to 400 μg Sc with an error of 0 to 2.6%. (JPRS)

35894 ESTIMATION OF THYROID IODINE IN VIVO BY ACTIVATION ANALYSIS. Lenihan, J. M. A. (Western Regional Hospital Board, Glasgow); Comar, D.; Riviere, R.; Kellershohn, C. Nature (London), 214: 1221-3(June 17, 1967).

Experiments were carried out with sheep, whose thyroid content is of the same order of magnitude as in man. Disadvantages in the use of ^{128}I are discussed. In the studies described ^{129}I was used as an internal standard. On thermal neutron irradiation ^{129}I yields ^{130}I and ^{130m}I, the gamma radiations of which occur at several energies between 0.41 and 1.15 MeV. The reactor beam employed was 5 cm dia at the neck of the sheep, and the thermal neutron flux was 3×10^8 n/cm^2/sec., with a further flux of 3×10^5 at energies about 0.5 eV. Irradiation time was 10 min. The gamma spectra obtained are reproduced, and estimates of thyroid iodine are tabulated. It could be inferred from the results that the iodine (present in organic form in the thyroid) is not dispersed by the circulation, despite the possibility of Szilard–Chalmers reaction. Application of the technique to humans is discussed. (UK)

35895 ANALYTICAL CHEMISTRY OF PLUTONIUM. Milyukova, M. S.; Gusev, N. L.; Sentyurin, I. G.; Sklyarenko, I. S. Analytical Chemistry of Elements Series. New York, Daniel Davey and Co., Inc., 1967. 382p. $21.00. (IPST-2126).

Translation of Analiticheskaya Khimiya Plutoniya by J. Schmorak.

A compilation of the latest information and extensive laboratory research on the analytical chemistry of plutonium is presented. Methods for practical application in research, mining, and industry are discussed. Particular attention is paid to the sensitivity of analytical methods with a view to achieving maximum accuracy in detecting traces of other elements. A subject index is included as well as 739 references. (P.C.S.)

35896 NON-DESTRUCTIVE AND DESTRUCTIVE NEUTRON ACTIVATION ANALYSIS OF THE IMPURITIES OF SILICON OF SEMICONDUCTOR PURITY. Nagy, L. G. (Polytechnical Univ., Budapest). Acta Chim. Acad. Sci. Hung., 52: 365-74(1967).

Nondestructive neutron activation analysis of silicon samples of different specific resistivity showed that active gold, sodium, and antimony can be detected in every case, and in some cases iridium and copper are also detectable. By this method a direct relation could be established between the quantity of the impurities and the value of specific resistivity. For determination of copper, gold, and silver, a combined alkaline–acid decomposition procedure was developed, which permits the utilization and the studying of the "scavenging effect" of silica gel prepared within the system. As evident by the results of measurements, these are considerably influenced by the treatment preceding activation (etching and washing), and by the binding of surface impurities before activation. (auth)

35897 RADIOMETRIC ERRORS IN DIFFERENT MODIFICATIONS OF THE ISOTOPE DILUTION METHOD. Shamaev, V. I. (Mendeleev Chemico-Technological Inst., Moscow). Zh. Anal. Khim., 22: 988-92(July 1967). (In Russian).

Different modifications of the isotope dilution method were compared. It was shown that the accuracy of determinations is higher when a version of the method based on the radiometric recording of the unseparated part of the determined element (the method of radiometric correction) is used. The radiometric error of the analysis by the method of radiometric correction depends on the separated amount of the determined element. (auth)

35898 SPECTROPHOTOMETRIC DETERMINATION OF CERIUM AND IRON WHEN THEY ARE PRESENT TOGETHER. Tikhonov, V. N. (All-Union Scientific-Research Aluminium–Magnesium Inst., Berezniki, USSR). Zh. Anal. Khim., 22: 886-90(June 1967). (In Russian).

A spectrophotometric method is reported for the determination of cerium and iron in the same solution by coloration of their complex compounds with complexone III and hydrogen peroxide in an alkaline medium. The absorption of the iron complex is measured at 530 nm and the total absorption of the cerium and iron complexes is measured at 372 nm. The cerium absorption is found by the difference. (auth)

35899 PHOTOCHEMICAL REACTIONS IN ANALYTICAL CHEMISTRY. COMMUNICATION 3. PHOTOMETRIC DETERMINATION OF MICROAMOUNTS OF URANIUM USING PHOTOCHEMICAL REDUCTION OF URANIUM(VI) TO URANIUM(IV). Nemodruk, A. A.; Bezrogova, E. V. Zh. Anal. Khim., 22: 881-5(June 1967). (In Russian).

Conditions were studied for the photochemical reduction of microamounts of uranium (VI) to uranium (IV) by ethanol in sulfuric acid solutions. It was found that reduction goes on quantitatively only in an inert atmosphere after removing the dissolved oxygen. By reducing uranium (VI) in a solution with the sulfuric acid concentration at 0.5 to 1 N, it was possible to determine the uranium (IV) formed by a photometric method using arsenazo III. Such combination of the photochemical reduction of uranium (VI) with the photometric determination of uranium (IV) permits a minimum of 0.5 μg of uranium to be determined with a reasonable accuracy. (auth)

35900 STUDIES OF SODIUM IN SiO_2 FILMS BY NEUTRON ACTIVATION AND RADIOTRACER TECHNIQUES. Buck, T. M.; Allen, F. G.; Dalton, J. V.; Struthers, J. D. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Electrochem. Soc., 114: 862-6(Aug. 1967).

Electrical instabilities in SiO_2 films under high fields at elevated temperatures were widely attributed to mobile ionic impurities, with sodium suspected as the most important ion. Phosphate glass treatments on SiO_2 are known to have a stabilizing effect. Neutron activation experiments to determine sodium contamination on and in steam-grown SiO_2 films and also diffusion and drift experiments with tracer sodium are reported. Phosphate glass-treated SiO_2 films were included in the samples. SiO_2 films grown and handled under various conditions had sodium densities of 7×10^{11} to 3×10^{14} atoms/cm^2, which could be easily removed or exchanged by washing and light etching. Densities remaining inside the 6000 Å films after washing and light etching were $\geq 4 \times 10^{11}$ – 4×10^{12}/cm^2. Tracer diffusions into SiO_2 at 600°C produced profiles that were high near the surface and lower through the interior of the film, similar to those observed by neutron activation for unintentional sodium contamination. Phosphate glass layers on SiO_2 absorbed and stopped the sodium under similar

conditions. With an applied field at elevated temperature (+4v, 1 min, 400°C) tracer sodium drifted through an SiO_2 film under gold dot electrodes, piled up at the Si–SiO_2 interface, and carried a substantial part of the charge transported. There was no detectable diffusion in uncharged areas. A layer of phosphate glass applied over an SiO_2 film absorbed sodium and prevented it from drifting into the SiO_2 film under the gold dots. (auth)

35901 INFLUENCE OF QUARTZ IMPURITIES ON THE CLEANLINESS OF ANNEALED SEMICONDUCTOR SURFACES. Fraenz, I.; Langheinrich, W. Telefunken Ztg., 39: 365-9(1966). (In German).

In many respects the electrical properties of semiconductor devices are dependent on the cleanliness of the surface. Analytic examinations of numerous wafers by neutron activation lead to a study of the causes of these surface impurities. An important source was found in the quartz glass used in the annealing process. Quartz glass contains impurities in varying quantities. Different proportions of Na, K, Sb, As, Cu, and Au were found by neutron activation in numerous tests of both newly made quartz types and such types as were used in semiconductor production for some time. The increase of alkali content was obvious when the quartz tube was used for some time. By annealing bare and oxidized Si wafers in neutron-activated quartz sleeves the adsorption of Na, Cu, Sb, As, and Au from quartz could be ascertained directly. The distribution of these elements on the wafers as well as their very unequal diffusion out of the quartz sleeve are investigated. (auth)

35902 MASKING EFFECT, FOREIGN SUBSTANCE CONTENT, AND STRUCTURE OF VARIOUS SILICON DIODE LAYERS. Fraenz, I.; Langheinrich, W. Telefunken Ztg., 39: 348-58(1966). (In German).

Thin silicon dioxide layers produced on Si by various methods were examined by radiochemical methods using the isotope ^{32}P as regards their diffusion-inhibiting effect for P_2O_5. In addition activation analyses were undertaken on the foreign substance content of the oxides and their structures compared by infrared absorption. Once the wafers were exposed to the same preliminary treatment they were coated with a layer of SiO_2 by various methods. With small P quantities under conditions such as prevail in diffusion furnaces without the source switched on, it was found that only crater-shaped adsorption and diffusion take place, and channels were found to penetrate the Si. At high P amounts, a homogeneous phosphorus glass layer is formed. Differences were not discovered in the thickness of this glass layer of the various oxides under uniform diffusion conditions. From this glass layer separate channels extended further into the Si. The highest observed phosphor content in the Si which is concentrated in the channels, amounts to 10^{-8} to 10^{-9} g phosphorus/cm^2, irrespective of whether or not a glass or only channels are formed, and regardless of which oxide was used. The activation analyses indicated in all oxides a Au content in the order of magnitude of 10^{12} atoms/cm^2 and a content of Na of approx. 10^{14} atoms/cm^2. In the oxides produced by thermal oxidation the Na content may be reduced to ~2% by etching. This indicates that the main amount of Na is situated on the surface. The distribution of the contamination is shown, and a comparison of the infrared absorption reveals, at the most, differences in degree in this structure of the oxides and thus confirms the result of the diffusion investigations. (auth)

35903 MASS-SPECTROMETRIC ISOTOPE ANALYSIS OF SMALL SAMPLES USING ALUMINIUM OXIDE AS THE CARRIER MATERIAL. Schuetze, H.; Zahn, H. (Institut fuer Stabile Isotope, Berlin). Isotopenpraxis, 3: 131-3(Apr. 1967). (In German).

Aluminum oxide can successfully be applied as a carrier material in isotope analysis of small samples. This method has some advantages in comparison with that executed without carrier material because of its inert properties, its specific surface, and its high melting point. Examples are given for chemical treatment followed by the mass-spectrometric isotope analysis of copper and sulfur samples in microgram amounts using aluminum oxide as the carrier material. (auth)

35904 DETERMINATION OF RARE EARTHS AND OTHER TRACE IMPURITIES IN LEAD ZIRCONATE TITANATE CERAMICS BY NEUTRON ACTIVATION ANALYSIS AND PIEZOELECTRIC PROPERTIES OF LEAD ZIRCONATE TITANATE CERAMICS AS MODIFIED BY SMALL QUANTITIES OF RARE EARTH, URANIUM, AND HAFNIUM ADDITIVES. Beard, Howard Richard. Salt Lake City, Utah, Univ. of Utah, 1966. 170p.

Thesis.

A neutron activation method was developed for the determination of rare earths and U in lead–zirconate–titanate (PZT) ceramics used in piezoelectric transducers for sonar. In order to determine the impurities in PZT ceramics and ZrO_2 samples, the flux and cross section of each of the elements analyzed had to be determined for the irradiation facility VP-7 at the Materials Testing Reactor. Cobalt metal was used as a primary standard for neutron flux determination and zirconium metal was developed as a secondary standard. Cobalt was not used for the flux determination in the analytical procedure since its large cross section and hence high activity after irradiation rendered it unsuitable for the purpose of this analysis. Thermal neutron activation cross sections were determined for the following isotopes: ^{23}Na, ^{50}Ti, ^{55}Mn, ^{86}Sr, ^{94}Zr, ^{180}Hf, ^{121}Sb, ^{115}In, ^{50}Cr, ^{238}U, ^{63}Cu, ^{45}Sc, ^{176}Lu, ^{174}Yb, ^{169}Tm, ^{170}Er, ^{165}Ho, ^{164}Dy, ^{159}Tb, ^{158}Gd, ^{151}Eu, ^{153}Eu, ^{152}Sm, ^{146}Nd, ^{141}Pr, ^{140}Ce, ^{142}Ce, and ^{139}La. These impurities were found in the PbO, TiO_2, $SrCO_3$, and/or ZrO_2 raw materials, which comprise the PZT ceramics. Gross gamma spectra analyses were used for analyzing the PZT ceramics and ZrO_2 samples for the major elements and impurities except for the rare earth and U impurities. The neutron-activated rare earths were separated from the major elements and impurities of the PZT ceramics by lanthanum fluoride precipitations. Then the rare earths were separated from each other on a cation exchange column using 0.5M alpha-hydroxyisobutyric acid. The complete separation of the rare earths required about 10 hours. The gamma spectra were then obtained for the radioactive rare earths nuclides. Six different commercial samples of PZT ceramics, samples of ZrO_2, and two standards were analyzed for their impurities. The samples were found to contain about 400 ppM Hf, 70 to 80 ppM U, 200 to 400 ppM rare earths, and one sample had about 120 ppM Ce impurity. The piezoelectric properties of these samples were also obtained. The Hf and U impurities did not appear to have an appreciable effect on the piezoelectric properties. The rare earth impurities appeared to increase the coupling constant and the Ce impurity appeared to lower this constant. An accuracy of ±5% was obtained in the analysis of the rare earth impurities in ZrO_2. Activation analysis by using gross spectra of the PZT ceramics also had an accuracy of ±5% in the composition analyzed and composition mixed in the PZT ceramics. The maximum concentration variation in the rare earth analyses between duplicate samples of the PZT ceramics was about ±15%. When the average of two samples was taken, the accuracy of rare earth concentration was about ±10%. (TSS)

35905 DEVELOPMENT OF AN X-RAY FLUORESCENCE METHOD FOR THE ANALYSIS OF CERIUM–IRON ALLOYS. Zabielski, Chester Vincent. Pittsburgh, Univ. of Pittsburgh, 1965. 59p.

Thesis.

An x-ray fluorescence method was developed for Ce in Fe by determining the curve of the CeL_{α_1} radiation intensity versus Ce additions up to 33% in levitation-melted ingot Fe. Factors affecting the curve and Ce recovery and retention were investigated. Homogeneity of the prepared standard samples is demonstrated by x-ray fluorescence techniques. (Disser. Abstr.)

35906 DETERMINATION OF ALUMINUM AND CADMIUM BY NEUTRON ACTIVATION OF THEIR CHELATES. Reed, Gareth La Verne. College Park, Md., Univ. of Maryland, 1966. 92p.

Thesis.

Neutron activation analysis of aluminum and cadmium by using an activatable-isotope labeling technique was investigated. The elements were labeled with stable bromine by forming a metal chelate using 5, 7-dibromo-8-quinolinol. Preirradiation separation was affected by using solvent extraction and paper chromatography techniques to isolate the pure chelate compound. Chromatograms containing isolated Al and Cd dibromoxine were irradiated in the University of Maryland pool-type nuclear reactor with a flux of 10^{11} n/cm^2/sec. The induced ^{82}Br activity was counted with a well-type NaI crystal and a single channel spectrometer. This method resulted in the quantitative determination of Al and Cd at concentration levels of 0.01 and 0.2 μg, respectively, with a total integrated activation flux of 3×10^{15} nvt. Difficulty was encountered in developing a satisfactory chromatography system. However, it was determined that the Al chelate was much more insoluble than many other chelates. Therefore, the contaminating chelates and the excess reagent were extracted from the Al chelate using a methanol–pyridine–acetic acid solution (50:6:1 v/v), which left the Al chelate precipitate at the origin of the chromatogram. For Cd, a two-step chromatographic system was used. A paper-loop chromatogram analogous to a two dimensional chromatogram was developed for use with this two-step technique. The excess reagent was removed in one direction on a chromatogram paper strip in heptane. The end of the chromatogram containing the excess reagent was then cut off and the remaining portion developed in methanol–pyridine–acetic acid (50:6:1 v/v). By this method Cd chelate was moved in a direction opposite to that of the excess reagent on a single strip of chromatography paper with an R_f of approximately 0.5. The mea-

sured sensitivity of this method is 3 and 10 times better for Al and Cd, respectively, than the sensitivities for direct activation of these metals based on obtaining 1000 dpm after irradiation for eight hr at a thermal neutron flux of 10^{11} n/cm²/sec. Further refinement of the pre- and post-irradiation procedures can increase the experimental sensitivity of this method since sensitivities for Al and Cd dibromoximates at the above conditions are 6 and 30 times better, respectively, than can be obtained by direct neutron activation analysis. Also, the characteristic half-life of the dibromoximates (35.9 hr) offers an advantage, particularly for Al where the 2.3 min half-life requires special equipment to even approach the calculated sensitivity. (Disser. Abstr.)

35907 REAGENTS, MEANS, AND METHOD FOR THE DETECTION OF URANIUM. Jungreis, Ervin; Ben-Dor, Lina (to Yissum Research Development Co.). British Patent 1,076,615. July 19, 1967. Priority date Nov. 29, 1963, Israel.

A reagent was prepared for the detection of U by treating the reaction product of p-dimethylaminoaniline hydrochloride and salicylaldehyde with NH_3. The original red color of the reaction product is converted to yellow by the action of the NH_3, and for detection of U the reagent is suitably carried by filter paper. By comparison of reactions produced by standard uranyl solutions with the impregnated filter paper, it is possible to estimate the concentration of unknown uranyl solutions. (B.L.M.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 35902, 35987, 35995, 36009, 36020, 36049, 36073, 36139, 36826, 36827, 36932, 37242, 37617, and 38199.

35908 (AWRE-O-50/67) REACTION OF HYDROGEN WITH METAL DEUTERIDES. Jones, P. M. S.; Gibson, R. (Atomic Weapons Research Establishment, Aldermaston (England)). July 1967. 10p. Dep. CFSTI. UK 1s. 9d.

The exchange and gettering kinetics for the reaction between erbium deuteride films and hydrogen gas showed that oxide barriers inhibit exchange and retard but do not stop gettering. (auth)

35909 (AWRE-O-74/63) PROTOTYPE FAST REACTOR FUEL ELEMENT PROJECT. THEORETICAL ASPECTS OF THE DESIGN AND OPERATION OF CONTINUOUS CHEMICAL PRECIPITATORS. Stevenson, D. G. (Atomic Weapons Research Establishment, Aldermaston (England)). [nd]. 34p. Dep.

Factors involved in continuous precipitation and precipitator operation were examined in order to define the methods by which the best product and optimum design may be achieved. After distinguishing between units in which nucleation is slow compared with the rate of mixing and units for which the converse situation holds, it is shown that the mean residence period of the precipitate is a crucial parameter, whereas, the liquor residence period is of little consequence. It was found from an examination of the mass/size-age distribution that the product does not reach equilibrium until about 10 mean residence periods have elapsed after start up. Considerable control of precipitate characteristics can be exerted by selecting the appropriate ionic conditions (pH, complexing agents, etc.) the optimum conditions involve fairly high solubilities, so that in a single-stage precipitator a compromise with efficiency is necessary. The zeta potential on the precipitate must approach zero, to avoid excessive nucleation. In order to make utmost use of the principles enumerated, for the production a fast-filtering precipitate, it is necessary to use a multistage unit. The available types and the theory of design and operation are discussed. Examples are drawn mainly from ammonium diuranate precipitation. (auth)

35910 (BNWL-457) ABSORPTION SPECTRA OF THORIUM DIOXIDE. Bates, J. Lambert (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1967. Contract AT(45-1)-1830. 16p. Dep. CFSTI.

The absorption spectra of single crystal and polycrystalline ThO_2 were determined for the spectral range 0.247 to 13 μ. Complex changes in the ultraviolet and visible spectra occurred when the oxide was heated in hydrogen or air. Absorption bands at 0.71 μ and 0.403 μ were observed when ThO_2 was annealed in hydrogen at 1700°C. Annealing ThO_2 in air at 1000°C removed these bands and produced an intense band at 0.306 μ. The absorption in the infrared range was the same for both single crystal and polycrystalline ThO_2, and was independent of the annealing conditions. The characteristic absorption edge is 5.02 eV. (auth)

35911 (CEA-R-3134) LES EFFETS ISOTOPIQUES EN SPECTROMETRIE DE MASSE. (Isotope Effects in Mass-Spectrometry). Leicknam, Jean-Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1967. 107p. (In French). Dep.

The influence of isotopic substitution on the stabilities of ionized molecules and the bond-breaking probabilities is reviewed; metastable transitions are also affected by this substitution. A model based on the Franck–Condon principle accounts for the experimentally observed isotopic effects for diatomic molecules; to a certain extent it is possible to generalize the calculation for the case of isotopic molecules of carbon dioxide gas. For deuterated polyatomic molecules there exists a π effect making it possible to compare the relative stabilities of the X-H and X-D bonds, and a γ effect, which characterizes the different behaviors of the X-H bond in a normal molecule and in its partially deuterated homolog. Usually there is a very marked π effect (e.g., the C–D bonds are more difficult to break than the homologous C–H bonds) and a γ effect, the partial deuteration of a molecule leading in general to an increase in the probability of breakage of a given bond. An interpretation of π and γ effects based on Rosenstock's near-equilibrium theory accounts for the observed phenomena, qualitatively at least, in the case of propane and acetylene. Results concerning isotopic effects produced during the formation of rearranged ions are discussed. The existence of cyclic transition ions made it possible for McLafferty to explain the existence of these ions in the mass spectrum; isotopic substitution leads to a modification of the rearrangement mechanism, the bonding forces being no longer the same. (111 references) (auth)

35912 (CEA-R-3235) CONTRIBUTION A L'ETUDE DE LA STRUCTURE MOLECULAIRE DE L'HEXAFLUORURE D'URANIUM. (Study of the Molecular Structure of Uranium Hexafluoride). Bougon, Roland (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). June 1967. 106p. (In French). Dep.

Thesis.

The vibrational spectrum of uranium hexafluoride has been studied in both the gaseous and solid states. The study of gaseous UF_6 confirmed the regular octahedral structure of the fluorine atoms around the central U atom and made it possible to evaluate some of the vibrational frequencies. From these, some new force constants have been determined. A tetragonal distortion was observed on solid UF_6. (auth)

35913 (COO-1087-104) MECHANISMS OF SUBSTITUTION REACTIONS OF METAL COMPLEXES. Technical Progress for 1966–1967. Basolo, Fred; Pearson, Ralph G. (Northwestern Univ., Evanston, Ill. Dept. of Chemistry). Apr. 30, 1967. Contract AT(11-1)-1087. 17p. Dep. CFSTI.

Developments in the following projects are reported: nucleophilic reactivity series for Pt(II) complexes and tetrahedral carbon; ionization potentials of metal chelates; theoretical calculation of bonding energies in class (a) and class (b) metal halides; soft nature of cesium ion; syntheses and reactions of some Ir(III) complexes; linkage isomerization and reactions of some Pd(II) complexes; structure of $Ni(CN)_5^{3-}$; and hydrolytic cleavage of bridged complexes of Co(III). (J.G.B.)

35914 (COO-1440-3) MIXED CONDUCTION IN SOLID OXIDE ELECTROLYTES. Rapp, Robert A. (Ohio State Univ., Columbus. Dept. of Metallurgical Engineering). June 1967. Contract AT(11-1)-1440. 33p. (CONF-670915-2). Dep. CFSTI.

For Presentation at Symposium on Thermodynamics of Nuclear Materials with Emphasis on Solution Systems, Vienna, Austria.

At temperatures between 800 and 1100°C, electric conductivity and galvanic cell measurements involving ThO_2, Dy_2O_3, and Gd_2O_3 indicated significant ionic conductivity contributions, in addition to electronic conduction. These measurements may be rationalized either on a basis of high intrinsic ionic defect concentrations, or else ionic defects introduced by trace impurities. For ThO_2, the latter explanation seems probable. The P_{O_2}-dependence of ac conductivity measurements in $ThO_2-Y_2O_3$ solid solutions showed a wide P_{O_2}-range of predominant ionic conductivity (σ_{ion}), with significant positive hole contributions ($\sigma_\oplus$) at higher oxygen activities. A dilute solution model was used to interpret the dependences of $\sigma_\oplus$ on P_{O_2} and Y_2O_3 content. The behavior of $\sigma_\oplus$ is consistent with the existence of doubly ionized (unassociated) oxygen vacancies in electrical compensation of trivalent dopant ions. As previously reported, the ionic conductivity contribution reaches a maximum with increasing Y_2O_3 dopant content. No significant excess electron conductivity contribution ($\sigma_\ominus$) was indicated for any $ThO_2-Y_2O_3$ composition at oxygen activities as low as those for $Cr-Cr_2O_3$ equilibrium coexistence. A dc polarization technique was used for direct measurement of $\sigma_\oplus$ and $\sigma_\ominus$ in $Zr_{0.85}Ca_{0.15}O_{1.85}$ and $Th_{0.85}Y_{0.15}O_{1.925}$ electrolytes. An improved method for the analysis of the data and experimental difficulties of this technique is discussed. A lower limit in P_{O_2} for predominant ionic conduction is reported for each electrolyte. Galvanic cells involving the use

of the $Zr_{0.85}Ca_{0.15}O_{1.85}$ electrolyte were used to determine the solubility and diffusivity of oxygen in solid copper. Difficulties in the method and the reliability of the results are discussed. (auth)

35915 (HW–83998) ^{233}U REDUCTION: STUDY FLOW SHEET. Curtis, M. H. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Sept. 15, 1964. Contract AT(45-1)-1350. 10p. DTIE.

A flow sheet was prepared for use in studies related to the final steps of processing ^{233}U nitrate to the metal. It is based entirely on the work of others with uranium processing on this scale. Several assumptions were made in setting up the flow sheet, which are: Sufficient time will have elapsed (since the primary separation) for the ^{232}U daughter growth to require daughter removal prior to subsequent processing. Primary separation product will contain sufficient metallic impurities to require additional cleanup. Processing will utilize a minimum amount of handling of dry powder. One-kilogram batches will be processed (easily converted to other quantities). (auth)

35916 (IA–1068) INVESTIGATIONS OF LANTHANIDE–NITRATE INTERACTIONS IN FUSED SALTS. Padova, J., Peleg, M.; Soriano, J. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). June 1967. 29p. Dep.

The interactions between lanthanide and nitrate ions in solutions of fused salts were investigated by means of absorption spectrophotometry, density, and emf measurements. The effects of concentration, temperature, and solvent media are discussed. At least two species are shown to be present, Nd^{3+} at low concentrations and unidentified complexes $Nd(NO_3)_{3-n}^{n+}$ at higher concentrations. (auth)

35917 (NP–16714) PROYECTO DE UN SISTEMA PARA CONTROLAR AUTOMATICAMENTE EL PROCESO DE PRECIPITACION DE URANIO EN LA PLANTA PILOTO DE LA COMISION NACIONAL DE ENERGIA NUCLEAR. (Design of an Automatic Control System for Uranium Precipitation in a Pilot Plant of the National Atomic Energy Commission). Enrique Ortega Espinosa, J. (Instituto Politecnico Nacional, Mexico City. Escuela Superior de Ingenieria Mecanica y Electrica). 1965. 189p. (In Spanish). Dep.

Thesis.

The pilot plant design is briefly outlined. The precipitation process used was analyzed to determine an electronic sensor to simplify routine operation. A comparison was made of the information obtained by a pH meter and a photoelectric cell used as sensors of the uranium precipitation process. The design of the automatic control system developed is considered in detail with a description of the operation of each control device in the operation. These include tank level control, temperature and agitation control, precipitation control, sodium hydroxide excess control, tank discharge control, and power source. The stability of the system was measured. An economic study was made of the utilization of such a system. (J.S.R.)

35918 (NYO–2082-12) HIGH TEMPERATURE INORGANIC CHEMISTRY. Ninth Annual Progress Report. Grosse, A. V.; Cahill, J. A. (Temple Univ., Philadelphia, Pa. Research Inst.). July 31, 1967. Contract AT(30-1)-2082. 30p. (RITU–1967-16). Dep. CFSTI.

Research progress is reported on: general physical and chemical relationships; electric conductivity of liquid Sn, Pb, and Bi; density of U–Be alloys; surface tension of liquid uranium and thorium tetrafluorides; behavior of solid and liquid gallium on mercury at room temperature; mercury wires; centrifugal plasma jet furnace; and interaction of W with Ag and Cu. (M.C.G.)

35919 (NYO–2873-23) ELECTROLYTE SOLUTIONS. Final Report, September 1, 1961–August 31, 1966. Braunstein, Jerry (Maine Univ., Orono. Dept. of Chemistry). Mar. 31, 1967. Contract AT(30-1)-2873. 23p. Dep. CFSTI.

Developments are reported for studies on: emf measurements in molten nitrates; silver–silver halide electrodes; thermodynamic association constants; solvent effects; concentrated aqueous electrolyte solutions; hydration and association in aqueous melts; polarography of aqueous melts; volumetric behavior of aqueous melts; vapor pressures of aqueous melts; mixed ligand association in molten salts; chronopotentiometry of molten nitrates. (P.C.H.)

35920 (ORO–2069-64) CHEMICAL PHENOMENA IN PURE AND MIXED SOLVENTS. Progress Report. (Arkansas Univ., Fayetteville. Dept. of Chemistry). Apr. 14, 1967. Contract AT(40-1)-2069. 203p. Dep. CFSTI.

Developments are reported for studies on: coaxial NMR cell; electromotive force of the silver–silver iodide, hydrogen iodide, hydrogen cell and the activity of hydrogen iodide in water–methanol media; electron exchange reaction between U(VI) and Sn(II) in ethanol–water media; automatic distillation apparatus; NMR evidence of solvation by dioxane in aqueous dioxane solutions of $Al(ClO_4)_3$; conductance of uranyl nitrate—the Debye-Falkenhagen effect. A review on NMR studies of ions in pure and mixed solvents is included, and 366 references are given. (P.C.H.)

35921 (TID–23921) CONSTRUCTION AND INSTALLATION OF EQUIPMENT FOR THE STUDY OF URANIA GELS. Progress Report. Im, S. J.; Wadsworth, M. E. (Oak Ridge National Lab., Tenn. Utah Univ., Salt Lake City. Inst. of Metals and Explosives Research). June 1967. Contract W-7405-eng-26; Subcontract 2176. 8p. Dep. CFSTI.

A series of 4 interconnected 11-gage stainless steel dry boxes was constructed. One box was designed to prepare urania gel and sol, one to grind, sieve, press, and weigh the gel, and two to contain water-cooled resistance furnaces for sintering and grain growth studies. A water cooling system, electricity supply system, and atmosphere supply system were constructed for each box. The reduction flask, precipitation flask, liquefaction flask, filter, porosimeter, gas chromatograph, sorptiometer, polarograph, and furnaces are described. (M.C.G.)

35922 (TID–23957) CHARACTERIZATION OF THORIA GEL BY INFRARED SPECTROSCOPY. Technical Report No. XXX. Olsen, C. S.; Wadsworth, M. E.; Olson, F. A. (Utah Univ., Salt Lake City. Inst. of Metals and Explosives Research). Jan. 31, 1967. Contract W-7405-eng-26; Subcontract 2176. 50p. Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

A surface study of thoria gel based on results of an in situ infrared technique indicated six possible forms of surface water, two adsorbed as molecular water and four as surface hydroxyl groups. One of the two forms of molecular water was physically adsorbed and easily removed while the other was strongly bonded, probably to surface nitrates. Of the four types of surface hydroxyl groups, one appeared to be nonhydrogen bonded, two were unique and appeared as rather monochromatic states of hydrogen bonding between hydroxyl groups, and the fourth form apparently involved hydrogen bonding with surface nitrates. Infrared evidence also indicated covalently bonded surface carbonates probably due to CO_2 contamination by air. Spectral assignments were verified as much as possible by controlled in situ surface reactions with H_2O, D_2O, and CO_2. Also the lattice structure of the ThO_2 gel surfaces were considered on the basis of (100), (110), and (111) planes to explain the spectral evidence of the various surface species adsorbed. The spectral results for three types of surface hydroxyl groups were explained on two bases. One basis considered the effect on hydrogen bonding of relative distances between surface hydroxyl groups at unique locations on the surface and the other basis considered the coordination of surface hydroxyl groups at unique locations on the (111) plane. A discoloration of the gel was observed on heating the gel in vacuum at 300°C. This discoloration was attributed to a defect state in thorium oxide. (auth)

35923 (UCRL–14188) APPROXIMATION TO THE THERMODYNAMIC EQUATION OF STATE FOR A MIXTURE OF HYDROGEN AND CARBON. Watts, J. L.; Stubbs, T. F. (California Univ., Livermore. Lawrence Radiation Lab.). May 11, 1965. Contract W-7405-eng-48. 13p. Dep. CFSTI.

The thermodynamic properties of a gaseous mixture of hydrogen and carbon have been approximated in the temperature and pressure regions below ionization by assuming that only the four chemical constituents H_2, H, C, and C_2H_2 are present. A simple and fast-running computer code has been created in FORTRAN to produce tables of entropy, enthalpy, density, and average molecular weight as functions of pressure, temperature, and mass fraction of hydrogen in the mix. A comparison of the data produced by this method and another more sophisticated technique is given. It is felt that agreement is adequate for the purposes for which the code was indicated. (auth)

35924 (UCRL–17602) I. REACTIONS OF SILANE, GERMANE, AND STANNANE WITH METAL– AND AMIDE–AMMONIA SOLUTIONS. II. PREPARATION AND REACTIONS OF POTASSIUM GERMYLTRIHYDROBORATE, $KGeH_3BH_3$. Rustad, Douglas Scott (California Univ., Berkeley. Lawrence Radiation Lab.). June 1967. Contract W-7405-eng-48. 59p. Dep. CFSTI.

Thesis.

I. Germane reacted with liquid ammonia solutions of potassium or potassium amide at –77° to form potassium germyl, germanium imide, and hydrogen gas. The fraction of the germane converted to germanium imide increased with increasing potassium concentration, but remained constant with increasing potassium amide concentration. Amide ion was an intermediate in the reaction of germane with metal–ammonia solutions. In the case of silane, the main reaction was ammonolysis, whereas in the case of stannane, no ammonolysis occurred. A general mechanism is pro-

posed to explain the results. II. Potassium germyltrihydroborate was prepared from the reaction of potassium germyl (in excess) with diborane in 1,2-dimethoxyethane. It was catalytically rearranged by diborane to form unstable products which subsequently decomposed into a germanium hydride polymer and potassium tetrahydroborate. It was relatively stable in alkaline solutions, hydrolyzed slowly in neutral solutions and hydrolyzed rapidly in acidic solutions to form germane and hydrogen in a 1 to 3 ratio. It was thermally decomposed above its melting point of 98.0 to 99.0° into a germanium hydride polymer and potassium tetrahydroborate. The infrared and proton magnetic resonance spectra are given. (auth)

35925 (LA-tr-67-50) TETRAHYDRATE ACETATES OF THE RARE EARTH ELEMENTS. Nadezhdina, G. V.; Ivanov, V. I.; Shubina, V.; Pliushchev, V. E. Translated by E. L. Head (Los Alamos Scientific Lab., N. Mex.), from Zh. Obshch. Khim., 36: 1560-3(1966). 8p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

Acetates of Sm, Dy, Ho, Er, and Lu were obtained by gradual dissolution of the rare earth oxides in 25% acetic acid at 70 to 80°C; the resulting solution was concentrated by evaporation until saturated. The acetates of Th and Yb were prepared by dissolving the appropriate hydroxide in dilute acetic acid. Analytical data showed that all of the acetates prepared had four waters of hydration with the general formula $Me(CH_3COO)_3 \cdot 4H_2O$. These compounds are prismatic crystals and exhibit oblique extinction. The solubilities of the compounds increased with increasing temperature. Refractive indices and densities were also determined. X-ray analyses showed that the compounds are isostructural. (M.C.G.)

35926 (LA-tr-67-62) STUDY ON THE ZIRCONIUM–CHLORINE SYSTEM. Uchimura, K.; Funaki, K. Translated for Los Alamos Scientific Lab., N. Mex., from Denki Kagaku, 33: 163-7(1965). 15p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Metallic zirconium and zirconium tetrachloride were made to react in a spring manometer made of quartz, and the change in gas pressure was measured. On initial heating, the gas pressure decreased from about 500°C but increased again from about 800°C. This gas pressure coincided with the expansion line for zirconium chloride originally introduced into the system. On the second and subsequent heatings, there was a sudden increase in gas pressure at approximately 400, 600, and 800°C. The gas produced at the points where the abrupt rise in gas occurs was in every case $ZrCl_4$. The reaction occurring in the vicinity of 400°C appeared to be $2\ ZrCl_3 \rightleftharpoons ZrCl_2(s) + ZrCl_4(g)$; the thermodynamic values obtained for this are $\Delta F^\circ = 18.97 \times 10^3 - 23.86\ T$. The reaction occurring at about 600°C appeared to be $3\ ZrCl_2 = 2\ ZrCl(s) + ZrCl_4(g)$. Although this differed from the conventional view that the reaction is $2\ ZrCl_2 \rightleftharpoons Zr + ZrCl_4(g)$, it does explain the production of gas at about 800°C. The thermodynamic values obtained for $3\ ZrCl_2 \rightleftharpoons 2\ ZrCl(s) + ZrCl_4(g)$ are $\Delta F^\circ = 22.53 \times 10^3 - 23.22\ T$. The reaction occurring at about 800°C appeared to be $4\ ZrCl(s) \rightleftharpoons 3\ Zr(s) + ZrCl_4(g)$, for which the thermodynamic values were found to be $\Delta F^\circ = 40.53 \times 10^3 - 34.56\ T$. Using these results, the heat of formation and entropy were found for $ZrCl_3(s)$, $ZrCl_2(s)$, and $ZrCl(s)$. The heats of formation were: 171.9, 117.8, and 61.9 (kcal); and the entropies 47.6, 33.8, and 19.6 (cal/deg · mole). The mechanism of the production of the lower zirconium chlorides through the interaction of metallic zirconium and zirconium tetrachloride was investigated. (auth)

35927 MONONUCLEAR HYDROLYSIS COMPLEXES OF THORIUM. Beran, M. (Inst. for Nuclear Research, Prague). Collect. Czech. Chem. Commun., 32: 1368-73(Apr. 1967). (In German).

The mean effective charge of the thorium hydrolysis complexes in relation to the hydroxide ion concentration was determined by means of two cation exchangers differing only by the swelling power. From the results it appears that under the present experimental conditions only the mononuclear hydrolysis complexes $Th(OH)^{3+}$, $Th(OH)_2^{2+}$, $Th(OH)_3^{+}$, and $Th(OH)_4$ are formed. The stability constants of these complexes were calculated. (tr-auth)

35928 COCRYSTALLIZATION OF THORIUM WITH BARIUM SULFATE. Syromyatnikov, N. G.; Trofimova, L. A. Radiokhimiya, 9: 251-6(1967). (In Russian).

A comparison of the coprecipitation of Th by $BaSO_4$ was carried out in the presence of an excess or deficiency of SO_4^{2-} with respect to Ba^{2+}. The initial Ba content was 280 mg, and the Th content was 1.12 mg. The relative amount of Th in the $BaSO_4$ precipitate increased on decreasing the SO_4^{2-} to Ba^{2+} ratio in the solution. It was also possible to carry trace amounts of ^{234}Th activity by precipitation with $BaSO_4$. A series of $BaSO_4$ precipitates containing varying amounts of Th were prepared, and the precipitates were treated with 7N HNO_3. In all cases the stoichiometric amounts of Ba and Th going into solution were the same for any one precipitate, but the $BaSO_4$ precipitates containing the larger amounts of Th went into solution faster and the solubility of the precipitates was greater than those of a relatively pure $BaSO_4$ precipitate. X-ray analysis showed lines not belonging to thorium sulfate. It is possible that these lines belong to a complex of barium and thorium sulfates of a double salt type such as $nBaSO_4 \cdot mTh(SO_4)_2$. (TTT)

35929 INFRARED ABSORPTION SPECTRA OF COMPLEX THORIUM FORMATES. Evstaf'eva, O. N.; Ivanova, O. M.; Moiodkin, A. K.; Dvoryantseva, G. A.; Struchkova, M. I. (Inst. of General and Inorganic Chemistry, Moscow). Dokl. Akad. Nauk SSSR, 172: 860-2(1967). (In Russian).

A study of the composition of the higher, e.g., hepta and octo, formates of thorium points toward the presence of associated monodentate formate groups, because the highest coordination number of thorium is 12. Changes in the character of these associated groups were investigated on the basis of the infrared spectra of the compounds, as the mono- or bidentate nature of the ligand affects the point symmetry groups. The following thorium formates, with varying degrees of saturation of the coordination sphere, were investigated: $Th(HCO_2)_4.3H_2O$; $BaTh(HCO_2)_6.2H_2O$; $Cs_3Th(HCO_2)_7$; and $Cs_4Th(HCO_2)_8$. It was found that the spectra of the tetra and hexaformates of thorium were similar to the corresponding formates of strontium, barium, and lead. The x-ray diffraction study revealed that bridged formate groups are present in the thorium compounds. The hepta and octo formates exhibited additional infrared absorption bands. No C = O valence oscillations were found in the spectra. (TTT)

35930 NEAR-VISIBLE ABSORPTION SPECTRA OF THE $CsUO_2(NO_3)$ CRYSTAL. Newman, John B. (Johns Hopkins Univ., Baltimore). J. Chem. Phys., 47: 85-94(July 1, 1967).

The near-visible absorption spectrum of a single-domain crystal of cesium uranyl nitrate at 20°K is interpreted. Selection rules are given for a trigonally coordinated uranyl complex in a crystal having two molecules per unit cell. Lower lying levels, whose excitation gives rise to the fluorescent and magnetic series, were assigned as the A_2 and E species of the D_3 point group. Given these assignments, absorption between levels exhibiting the strongest fluorescence occurred only by allowed quadrupole transitions; a vibronic interaction is suggested to account for the radiative decay rates. Certain higher levels were assigned alternately, in pairs, to the A_{2g} and A_{2u} species of the D_{3d} point group as a consequence of the intermolecular interaction in the unit cell. Estimates of the strengths of the various interactions considered were required and, as a first step, the singlet-triplet intervals for two uranyl models were calculated and found to be comparable with, or less than, the spin–orbit splitting. (auth)

35931 SOME CHEMICAL PROPERTIES OF ELEMENT 97. Peterson, Joseph R.; Cunningham, Burris B. (Univ. of California, Livermore). Trans. Amer. Nucl. Soc., 10: 92-3(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35932 CHEAP HYDROGEN FOR BASIC CHEMICALS. Juda, W.; Moulton, D. M. (Prototech Co., Cambridge, Mass.). Chem. Eng. Progr., 63: No. 4, 59-60(Apr. 1967).

To improve the economics of the electrolytic generation of H_2, it is suggested that SO_2 be used to depolarize the O_2 electrode. This substantially reduces the electrolysis voltage and produces commercially valuable H_2SO_4. Two fertilizer schemes based on this procedure using low-cost nuclear power are examined. (auth)

35933 ELECTROLYSIS AS A SOURCE OF HYDROGEN AND OXYGEN. Costa, R. L.; Grimes, P. G. (Allis-Chalmers Mfg. Co., Milwaukee). Chem. Eng. Progr., 63: No. 4, 56-8(Apr. 1967).

By application of fuel cell technology, high-efficiency electrolytic cells were built and extensively tested. An economic study using low-cost nuclear power showed water electrolysis to be competitive for ammonia plants in areas where natural gas is not available and for H_2 and O_2 supply to other segments of the chemical industry. (auth)

35934 AMMONIA COSTS AND ELECTRICITY. Blanco, R. E.; Holmes, J. M.; Salmon, R.; Ullmann, J. W. (Oak Ridge National Lab., Tenn.). Chem. Eng. Progr., 63: No. 4, 46-50 (Apr. 1967).

A survey of 20 industries indicated that the production of ammonia fertilizers could use large blocks of power most efficiently at a large nuclear desalination site. With the use of advanced electrolytic cells at high current densities and low-cost nuclear power, competitive situations are evaluated for a range of power costs and are compared with conventional systems in the U. S. and abroad. (auth)

35935 SURFACE IONIZATION. I. DESORPTION OF U^+ IONS FROM W AND Re SURFACES. Hertel, G. R. (Oak Ridge

National Lab., Tenn.). J. Chem. Phys., 47: 133-7(July 1, 1967). (ORNL-P-2830).

The mean residence times (τ) of U^+ ions on polycrystalline W and Re surfaces have been measured as functions of the surface temperature. The U^+ desorption parameters were determined from the relationship $1/\tau = \omega_0 \exp[-E_i/kT]$. The effect of oxygen contamination on the W surfaces was dramatic. The Re results were not as clear cut. In the temperature range where uranium oxide ions were abundant, the simple desorption mechanism is complicated by surface reactions. The resulting $\log(\tau^{-1})$ vs T^{-1} relationship is complex and nonlinear. (auth)

35936 VIBRATIONAL AND ROTATIONAL EFFECTS ON THE NUCLEAR QUADRUPOLE COUPLING CONSTANTS IN HYDROGEN, DEUTERIUM, AND TRITIUM HALIDES. Tokuhiro, Tadashi (Tokyo Inst. of Tech.). J. Chem. Phys., 47: 109-13(July 1, 1967).

The differences of the nuclear quadrupole coupling constants in hydrogen, deuterium, and tritium halides were studied by considering effects of vibration and rotation on the field gradient. The variation of the coupling constant can be explained by the change in size of the molecule arising from the substitution of hydrogen by deuterium or tritium. (auth)

35937 SURFACE IONIZATION. II. THE FIRST IONIZATION POTENTIAL OF URANIUM. Hertel, G. R. (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 47: 335-6(July 1, 1967). (ORNL-P-2831).

Chlorella vulgaris growth is not quantitatively modified by the presence of $^{90}Sr-^{90}Y$ in an artificial medium, at least up to a concentration of 0.256 μCi/ml. Chlorella vulgaris growth is also not altered by stable Sr addition in the medium up to a quantity of 176 μg/ml. The uptake of Sr referred to 10^6 cells (y_{Sr}) is related to the concentration of Sr in the medium by the following equation: $y_{Sr} = 46.74 \cdot 10^{-5} x$, which is right in the range $0 \leq x \leq 1.76$ μg/ml. Therefore the concentration factor in living algae might be considered constant only in this range. The corresponding relation for Y is: $y_Y = 531 \cdot 10^{-5} x$. Radioactivity in algae, when separated from medium, is, on the average, 6.1% for ^{90}Sr and 70.80% for ^{90}Y, of the initial radioactivity introduced in the medium. Sr in algae is about 500 times greater in weight than Y, when both are added in the medium as furnished by Harwell (specific activity = 90 c ^{90}Sr/g Sr). From ratios Sr/Y in the medium and in the algae, from the RCU and from the coefficients of the two equations for Sr and Y, it results that Y uptake is, on the average, 8.89 times greater than Sr, when both Sr and Y are added in the medium at the same weight. (auth)

35938 A SPECTROPHOTOMETRIC STUDY OF THE THORIUM COMPLEX OF 2-(1,8-DIHYDROXY-3,6-DISULFO-2-NAPHTHYLAZO)-PHENOXYACETIC ACID. Miyata, Haruo (Okayama Univ., Japan). Bull. Chem. Soc. Jap., 40: 1875-8(Aug. 1967).

2-(1,8-Dihydroxy-3,6-disulfo-2-naphthylazo)-phenoxyacetic acid was synthesized. The acid dissociation constants of the reagent were determined spectrophotometrically at 25°C and at an ionic strength of 0.1. The reagent formed a violet 1:1 complex with thorium, showing an absorption maximum at 575 mμ in an acidic solution. The apparent stability constant of the thorium complex was measured over the pH range from 1 to 3.5. (auth)

35939 KINETIC STUDY OF THE REACTION BETWEEN URANIUM MONOCARBIDE AND WATER VAPOR. Hori, Yoshio; Mukaibo, Takashi (Tokyo Univ.). Bull. Chem. Soc. Jap., 40: 1878-83(Aug. 1967).

The rate of the reaction between uranium monocarbide and water vapor was investigated in a flow system under the conditions of 53 to 90°C and 20 to 120 mmHg. The rate of evolution and the composition of gases were measured by means of a gas chromatograph. The reaction versus time curve was sigmoid-shaped and found to be divided into three parts. Avrami's equation for nucleation and growth fit the first part. The second part was expressed by a quasi first order reaction. Rate constants for the first and the second parts were found to depend on the water vapor pressure, obeying Langmuir's adsorption isotherm. The activation energy for reaction and the heat of adsorption for the first part were determined to be 13.0 and 3.9 kcal/mol respectively. (auth)

35940 THERMODYNAMICS OF ZrO_2, MgO, AND CaO REACTIONS WITH HIGH-MELTING METALS. Yudin, B. F.; Markholiya, T. P. Ogneupory, No. 7, 46-52(July 1967). (In Russian).

A thermodynamic analysis of ZrO_2, MgO, CaO reactions with Mo, W, Nb, Ta, and Zr was carried out at 2000 to 3000°K. The relative intensity of the reactions and the temperature of the beginning of the reactions as a function of the pressure of surrounding media were determined. (R.V.J.)

35941 ACIDITY OF HYDROCARBONS. XXV. SECONDARY ISOTOPE EFFECTS IN THE LITHIUM CYCLOHEXYLAMIDE CATALYZED α-DEUTERIUM EXCHANGE OF RING-DEUTERATED TOLUENES. Streitwieser, A. Jr.; Humphrey, J. S. Jr. (Univ. of California, Berkeley). J. Amer. Chem. Soc., 89: 3767-70(July 19, 1967).

The protodedeuteration rates of toluene-α,4-d_2, -α,2,4,6-d_4, and -α,2,3,4,5,6-d_6 with lithium cyclohexylamide–cyclohexylamine at 50°C were dissected to the following isotope effects per ring deuterium: ortho, −2.4%; meta, −0.4%; para, −1.8%. These rate retardations are in the direction and of the order of magnitude expected for deuterium as an electron-donating substituent but the variations with position are not explicable on any simple general basis. (auth)

35942 ACIDITY OF HYDROCARBONS. XXVI. RATES OF EXCHANGE OF m- AND p-TRIMETHYLSILYLTOLUENE-α-d AND -α-t WITH LITHIUM CYCLOHEXYLAMIDE IN CYCLOHEXYLAMINE. Mares, F.; Streitwieser, A. Jr. (Univ. of California, Berkeley). J. Amer. Chem. Soc., 89: 3770-1(July 19, 1967).

Deuterium and tritium exchange rates were determined for m- and p-trimethylsilyltoluenes in cyclohexylamine catalyzed by lithium cyclohexylamide at 25°C. Tritium exchange rates relative to toluene-α-t are: meta, 1.01, $k_D/k_T = 3.3 \pm 0.3$; para, 4.57, $k_D/k_T = 3.0 \pm 0.1$. These results confirmed the conjugative electron withdrawal of a silyl group. Equivalent σ^- values are: m-$(CH_3)_3Si$, 0.00; p-$(CH_3)_3Si$, +0.17. (auth)

35943 THE ADSORPTION OF ^{147}Pm FROM SOLUTION ON TO METAL SURFACES. Mellish, C. E.; Payne, J. A. (Atomic Energy Research Establishment, Wantage, Eng.). Radiochim. Acta, 7: 153-8(June 1967).

The adsorption of ^{147}Pm from clean aqueous solutions onto metal surfaces was shown to be highly dependent on their composition and pre-treatment. The results indicated generally that a stable layer of oxide or hydroxide is necessary for adsorption to take place, and the pattern of adsorption was shown in different cases to demonstrate the presence of non-adsorbing sulfide and fluoride films, to distinguish between different surface components of an alloy specimen, and in the case of platinum to differentiate between different crystal faces of an etched sample. (auth)

35944 IODIDE EXCHANGE ON AROMATIC IODOAMINOACIDS. Marcopoulos, Christos A. (Democritos Nuclear Research Center, Athens). Radiochim. Acta, 7: 120-2(June 1967).

The isotopic exchange of iodine between [^{131}I] KI and monoiodotyrosine, diiodotyrosine, diiodothyronine, triiodothyronine, and thyroxine was studied. To separate the organic from the inorganic compound an ion exchange technique through a resin column was adopted and to follow the increasing activity of the iodoaminoacids a scintillation counter technique was applied. The reaction was followed at 37°C, in pure water, in Krebs–Ringer–Phosphate solution, and in aqueous solution of electrolytes of various ionic strength and with the range of organic and inorganic iodine concentrations found in blood. In order to establish the possibility of an effect of the exchange reaction on $PB^{131}I$, the fraction of exchange in 48 hr, in all conditions in which the reaction was followed, was determined. (auth)

35945 STUDY OF PLUTONIUM(III): SULPHATE COMPLEXES. Nair, G. M.; Rao, C. L.; Welch, G. A. (Atomic Energy Establishment, Bombay). Radiochim. Acta, 7: 77-80(June 1967).

The nature of complexes formed by plutonium(III) with sulfate ions was investigated at 1M hydrogen ion concentration in solutions of unit ionic strength by an ion exchange technique. The distribution coefficients of plutonium(III) were determined using an Amberlite IR-120 cation exchanger in the hydrogen form at 28°C. The stability constants of the complexes formed were calculated. The main complex species found were $Pu(SO_4)^+$ and $Pu(HSO_4)_2^{++}$ with stability constants of 18.13 ± 0.44 and 9.94 ± 0.24, respectively, indicating that both SO_4^- and HSO_4^- act as complexing agents in the acid medium. Anion exchange and electrical migration experiments supported the conclusions drawn from cation exchange studies regarding the nature of the complex species in solution. (auth)

35946 MECHANISTIC ORGANIC PHOTOCHEMISTRY. XXIV. THE MECHANISM OF THE CONVERSION OF BARRELENE TO SEMIBULLVALENE. A GENERAL PHOTOCHEMICAL PROCESS. Zimmerman, Howard E.; Binkley, Roger W.; Givens, Richard S.; Sherwin, Maynard A. (Univ. of Wisconsin, Madison). J. Amer. Chem. Soc., 89: 3932-3(July 19, 1967).

Mechanisms for the photosensitized conversion of barrelene to semibullvalene are proposed. On the basis of deuteration reactions, NMR analysis, and mass spectral analysis a reaction mechanism is selected. This mechanism is one example of a general type of excited-state transformation in which a divinylmethane moiety is converted into a vinylcyclopropane group. (B.L.M.)

35947 DIRECTLY OBSERVABLE CARBONIUM ION–CARBONIUM ION REARRANGEMENTS. II. KINETICS AND

EQUILIBRIA IN THE INTERCONVERSION OF TETRAALKYLCYCLOPENTENYL CATIONS. Sorensen, T. S. (Univ. of Calgary, Alberta). J. Amer. Chem. Soc., 89: 3794-3803 (July 19, 1967).

A series of methyl, ethyl, isopropyl, and t-butyl tetrasubstituted cyclopentenyl cations were prepared in which a facile equilibration takes place to yield both the 1,3- and the 2,4-dialkyl allylic cations. This system pits the various alkyl groups against one another and the results provide evidence in support of the hyperconjugative order. The value of the equilibrium constants so obtained, the kinetic rate constants of the equilibration reactions, the variation of equilibrium constants with temperature and solvent, the preparation of several of the ions in a deuterated acid solvent, and a detailed comparison of these quantities with those observed previously in a trialkyl series are reported. In the t-butyl-substituted ions an additional rearrangement was found, corresponding to a directly observable neopentyl-type rearrangement. The position of the ultraviolet absorption maximum of these ions showed a correlation with the number of carbon atoms in the ion. Finally, a new cyclopentadiene synthesis was discovered. (auth)

35948 SPECTRA OF URANIUM(IV) AND URANIUM(III) IN MOLTEN FLUORIDE SOLVENTS. Young, J. P. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Inorg. Chem., 6: 1486-8(aug. 1967). (ORNL-P-2781).

Spectra of U(IV) and U(III) in molten $LiF-BeF_2$, $LiF-BeF_2-ZrF_4$, and $LiF-NaF-KF$ were obtained at temperatures up to 540°C over the wavelength range of 200 to 2400 nm. Based on a comparison of these spectra with those obtained in other molten-salt systems and aqueous systems, it is suggested that the coordination number of the uranium species in the molten-fluoride media studied is possibly 8 or 9. Clearly, these ions are not in the environment found in chloride melts. By chemical means, it was not possible to obtain a solution of U(III) free of U(IV). The reaction of U(III) with alkali fluorides is discussed. (auth)

35949 THE DONOR PROPERTIES OF PYROPHOSPHATE DERIVATIVES. V. COMPLEXES OF $MoOCl_3$, UO_2^{2+}, AND Th^{4+} WITH OCTAMETHYLPYROPHOSPHORAMIDE. Joesten, Melvin D. (Vanderbilt Univ., Nashville). Inorg. Chem., 6: 1598-9(Aug. 1967).

Complex formation of oxycations and Th^{4+} with octamethylpyrophosphoramide (OMPA) and their properties were studied. Electrolytic characteristics and possible structural arrangement are presented for $MoOCl_3 \cdot OMPA$; $UO_2(ClO_4)_2 \cdot 3OMPA$; and $Th(ClO_4)_4 \cdot 4OMPA$. It was concluded that the ability of OMPA to coordinate as a bidentate ligand and the similarity in stoichiometry and ring size in the systems predicts an Archimedean antiprismatic structure for the thorium complex. (P.C.S.)

35950 SOLUTION PROPERTIES OF SOME HEXAFLUORIDES IN ANHYDROUS HYDROGEN FLUORIDE. Frlec, Boris; Hyman, Herbert H. (Argonne National Lab., Ill.). Inorg. Chem., 6: 1596-7(Aug. 1967).

Electric conductivities and Raman spectra of solutions of Mo, W, U, Rh, and Os hexafluorides in hydrogen fluoride were investigated to determine the degree of ionization. Solubilities were also determined. (P.C.S.)

35951 ENERGY TRANSFER AND COLLISIONAL DEACTIVATION IN THE REACTIONS BETWEEN D_3^+ IONS AND THE HYDROCARBONS. Aquilanti, V.; Galli, A.; Volpi, G. G. (CNEN, Rome. Univ., Rome). J. Chem. Phys., 47: 831-6(July 15, 1967).

D^+-transfer reactions from D_3^+ ions to alkanes and alkenes up to C_4 were studied by mass spectrometry in the deuterium pressure range from 0.1 to 1.0 torr and at field strengths between 1.7 and 42 V/cm. Deuteronated ions can, in general, be formed in different states, and all decompose along exothermic patterns. Collisional deactivation at the highest pressures can prevent the dissociation of states with lifetimes longer than 10^{-6} sec, while kinetic-to-internal energy transfer may contribute to populate those states that lead to faster dissociations. (auth)

35952 INDUCED ROTATION–TRANSLATION SPECTRA OF SOLUTIONS OF H_2, HD, AND D_2 IN LIQUID ARGON. Holleman, Gerald W.; Ewing, George E. (Indiana Univ., Bloomington). J. Chem. Phys., 47: 571-9(July 15, 1967).

Dilute solutions of H_2, D_2, and HD in liquid argon were studied by examining the 1000 to 140-cm^{-1} region of their induced absorption spectra. Since the absorption features overlap extensively, an empirical profile analysis was performed. For H_2 and D_2 several relatively sharp absorptions ($\Delta\nu_{\frac{1}{2}} \approx 30$ cm^{-1}), that have a Lorentzian line shape and closely correspond to the expected transitions of the freely rotating solute molecules, were observed. The width of these lines appeared to be due to uncertainty broadening, which depended on the time the absorbing solute molecule spent in a particular solvent cavity. Other features, with a 150-cm^{-1} half-width, were fitted with a four-parameter exponential equation and were believed to involve quantized translational energy levels of the solute. The range of translational energy levels, which is determined by the distribution of solvent cavity sizes, was responsible for their increased bandwidths. The HD spectrum was unusual in that the rotational selection rules were relaxed and transitions corresponding to $\Delta J = +2, +3$, and $+4$ were observed. Furthermore, all of the rotational absorption features were anomalously broad ($\Delta\nu_{\frac{1}{2}} \approx 50$ cm^{-1}) and their maxima were shifted from the gas-phase frequencies in an irregular pattern. Because of its asymmetrical mass distribution, rotational motion of HD was accompanied by a translation of the molecule in its solvent cavity. This rotation–translation interaction was given quantitative form in a perturbation treatment by Friedmann and Kimel, and the results are consistent with the observed selection rules, frequency shifts, and linewidths in the spectrum of HD in liquid argon. (auth)

35953 INFRARED SPECTROSCOPIC INVESTIGATIONS ON THE SO_3-H_2O AND SO_3-D_2O LIQUID SYSTEMS. PART I. THE INFRARED SPECTRUM OF ANHYDROUS SULFURIC ACID AND THE STRUCTURE OF AQUEOUS SULFURIC ACID SOLUTIONS. Stopperka, K. (Technical Univ., Dresden). Z. Anorg. Allg. Chem., 344: 263-78(June 1966). (In German).

The infrared spectra of aqueous H_2SO_4 solutions containing 5 to 100% H_2SO_4 were determined and presented. The spectra indicate that there exist both ionic (HSO_4^-, H_3O^+) and molecular (H_2O, H_2SO_4) varieties. It was also possible to follow the decomposition mechanism of the $(H_2O)_5$ adducts. The assignment of OH deformation vibrations was made possible by comparing the results with those obtained on the corresponding deuterated compounds. (JPRS)

35954 THEORY OF EQUILIBRIA OF COMPLEXES IN SOLUTION. II. THE COMPLEXITY OF URANYL THIOCYANATE BY AN IMPROVED METHOD OF CORRESPONDING SOLUTIONS. Kuan, I-wen; Hsu, Kuang-hsien (Peking Univ.). Hua Hsueh Hsueh Pao, 29: 37-43(Feb. 1963). (In Chinese).

The theoretical expression similar to the Freundlich adsorption isotherm proposed in a previous paper to express the relation between the degree of formation $\bar{n}$ and the free ligand concentration L in a solution of mononuclear metal complexes was verified for the system of uranyl thiocyanate complexes ($\mu = 1$, $[H^+] = 0.1$). It was found that $\bar{r} = 7.3\ [L]^{1.000}$, while the ratio Y_0 of the total concentration of U to that of the uncomplexed uranyl ion may be calculated by the following expression: $\log Y_0 = \int_0^{(L)} \bar{n}d[L]/[L] = 3.1\ [L]^{1.000}$. The average molar extinction coefficient ϵ_m at $\lambda = 436$ mμ was found to be $\epsilon_m = 350\ [L]^{0.755}$. (JPRS)

35955 SYNTHESIS OF PLUTONIUM HEXAFLUORIDE. Slivnik, Joze (Nuclear Inst. Josef Stefan, Ljubljana, Yugoslavia). Nukl. Energ., No. 4, 12-13(1965). (In Slovak).

Plutonium hexafluoride was prepared from PuF_4, which was synthesized free of plutonium trifluoride. The tetrafluoride was obtained by hydrofluorination of PuO_2 prepared from plutonium oxalate. One part of the product thus obtained was used for structural investigations while the other was used for the synthesis of PuF_6. The final product was obtained by the action of F_2 on PuF_4 under ~150 atm of pressure and a temperature of 500°C. The product was purified by vacuum sublimation; the surplus F_2 may be reused, which is an advantage of the method. Structural diagrams of the devices for PuO_2 hydrofluorination and PuF_6 synthesis are given. (JPRS)

35956 LONG-WAVELENGTH, INFRARED-ACTIVE FUNDAMENTAL FOR URANIUM, NEPTUNIUM, AND PLUTONIUM HEXAFLUORIDES. Frlec, Boris; Claassen, Howard H. (Argonne National Lab., Ill.). J. Chem. Phys., 46: 4603-4(June 15, 1967).

The long-wavelength, infrared-active fundamentals, ν_4, were observed for uranium, neptunium, and plutonium hexafluorides at 186.2, 198.6, and 206.0 cm^{-1}, respectively. The corresponding values predicted earlier from combination bands were 184, 198, and 203 cm^{-1}. From the P–R branch separations Coriolis zeta constants were calculated for these bands. (auth)

35957 GALVANIC CELLS AND GAS EQUILIBRATION TECHNIQUES. Markin, T. L.; Bones, R. J.; Wheeler, V. J. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Brit. Ceramic Soc., No. 8, 51-66(June 1967).

A high-temperature galvanic cell containing solid electrolytes, reversible to oxygen ions only, was used to measure oxygen potentials of non-stoicheiometric oxides of uranium and plutonium and metal/metal oxides, employing Ni, NiO and Fe, FeO as the reference electrodes. The cell functioned satisfactorily at very low oxygen potentials by comparison with data for the CeO_{2-x} system obtained by CO/CO_2 equilibrium experiments. A technique of titration of oxygen ions from the standard metal/metal oxide to uranium oxide was used for the region close to stoicheiometry,

where large changes in oxygen potential occur for a small change in composition. When sufficient attention is paid to practical aspects, which are discussed, these cells can function satisfactorily over a wide range of temperature and oxygen potential. A galvanic cell containing electrolytes reversible to fluoride ions was also developed and a high degree of internal consistency demonstrated by measurements of three sets of related cells. A new technique of gas-equilibration in a sealed silica system was developed, by which an oxide at temperatures above 1900°C is equilibrated with a reference metal/metal oxide mixture held at a lower temperature; oxygen is transferred by means of a H_2/H_2O gas mixture. (auth) (UK)

35958 CROSSED MOLECULAR BEAM REACTIONS OF TRITIUM BROMIDE. Martin, Robbin L.; Kinsey, James L. (Massachusetts Inst. of Tech. Cambridge). J. Chem. Phys., 46: 4834-8(June 15, 1967).

A radioisotope-detection method was successfully employed to determine the product distribution in crossed molecular-beam experiments. Angular distributions of the atomic tritium product were measured for the reactions K + TBr → KBr + T and Cs + TBr → CsBr + T. The measured distributions correspond to "backward" scattering ($\chi \simeq \pi$) of the potassium bromide relative to incoming potassium in the center-of-mass coordinate system for both reactions, i.e., the reactions are rebound reactions. (auth)

35959 ISOTOPE EFFECTS ON METASTABLE TRANSITIONS. II. $CH_3CD_2CH_3$ AND $CD_3CH_2CD_3$. Lifshitz, Chava; Shapiro, Moshe (Hebrew Univ., Jerusalem). J. Chem. Phys., 46: 4912-20(June 15, 1967).

Metastable transitions were studied in the mass spectra of 2,2-dideuteropropane and 1,1,1,3,3,3-hexadeuteropropane in a sector mass spectrometer. The relative abundances of the various metastable ions at 70 eV were determined. Two parent-ion metastable transitions were studied carefully: the methane- and hydrogen-atom eliminations. The metastable transition at m/e = 19.6, due to the elimination of CH_4 from $CH_3CD_2CH_3^+$, is very abundant, amounting to 0.19% of the total ionization at 70 eV. No metastable transition was, however, observed for either of the methane eliminations (CD_4 or CD_3H) from $CD_3CH_2CD_3^+$. Similarly, no transition was observed for the CH_3D elimination from $CH_3CD_2CH_3^+$. The transitions at m/e = 48.1, due to H loss from $CD_3CH_2CD_3^+$, and at m/e = 42.1 due to D loss from $CH_3CD_2CH_3^+$, were both observed. Reaction rate constants were determined for these transitions, as well as for the transition due to D loss from perdeuterated propane. Results are discussed in terms of the quasiequilibrium theory of mass spectra. (auth)

35960 ANODIC DEPOSITION OF CURIUM. Haissinsky, Moise; Pluchet, Elisabeth (Laboratoire Curie, Paris). J. Chim. Phys., 64: 737-8(Apr. 1967). (In French).

The conditions under which anodic deposition of Cm occurs were investigated. At potentials between 1.35 and 1.75 V with respect to the hydrogen electrode, curium is deposited on the anode, with the quantity deposited increasing at first rapidly with time and then passing through a maximum, and decreasing more or less slowly. The maximum deposited increased generally with the anode potential. Studies on the chemical properties of the deposit show it to be an oxide and hydroxide of higher valence and unstable. Hydrogen peroxide has a reducing and dissolving action on the deposit. (J.S.R.)

35961 MECHANISM OF THE PYRIDOIN CONDENSATION. Schaefer, John P.; Bertram, James L. (Univ. of Arizona, Tucson). J. Amer. Chem. Soc., 89: 4121-4(Aug. 2, 1967).

When pyridine-2-aldehyde is dissolved in acetic acid, 2,2'-pyridoin is formed. The reaction is second order in aldehyde and is catalyzed by acids and metal ions. At 70°C an isotope effect (k_{RCHO}/k_{RCDO}) of 2.52 was measured, which indicates that the aldehydic hydrogen bond is being broken in the rate-determining step. A mechanism that involves nucleophilic addition of the aldehyde to its conjugate acid followed by a rate-determining removal of a proton, cyclization, and elimination is proposed. (auth)

35962 STUDIES ON THE MECHANISM OF ISOMERIZATION AND ^{18}O EXCHANGE OF GLYCEROPHOSPHORIC ACID IN AQUEOUS SOLUTIONS. Fordham, William D.; Wang, Jui H. (Yale Univ., New Haven). J. Amer. Chem. Soc., 89: 4197-4203(Aug. 2, 1967).

The rate of acid-catalyzed isomerization of glycerophosphoric acid was measured both by periodic acid oxidation and by nmr techniques as a function of acid and substrate concentrations, temperature, and deuterium atom % in solvent water. The observed rates of isomerization are about 10^3 times the rates of hydrolysis of the phosphoglyceric acids. Most of the difference in rates of the two reactions can be accounted for by the difference in apparent activation energies. The rates of isomerization and hydrolysis increased on changing the solvent from H_2O to D_2O, indicating a fast protonation of glycerophosphoric acid prior to the rate-determining step. A kinetic study of ^{18}O exchange between water and glycerophosphoric acid indicated that the isomerization occurs both with and without the formation of a cyclic intermediate. A detailed kinetic treatment is given for the dual-path isomerization mechanism. (auth)

35963 COMPLEXES OF URANIUM, SILVER, AND CADMIUM WITH MERCAPTOSUCCINIC ACID. Sinha, S. C.; Nigam, H. L. (Univ. of Allahabad, India). Indian J. Chem., 5: 117-19 (Mar. 1967).

A potentiometric study of the complexes of d^{10} configuration metal ions, viz U(VI), Ag(I), and Cd(II) with mercaptosuccinic acid (MSA) showed that the ratios of metals to MSA in the complexes are: 1:2 for U(VI); 1:1 for Ag(I); and 1:1, and 1:2 for Cd(II). Stepwise stability constants and free energy of formation of the complexes were evaluated from the potentiometric data. The silver complex, isolated in the solid state, had the same stoichiometry (by analysis) as in solution. Magnetic susceptibility measurements show that the silver complex has ($5s5p^3$) tetrahedral structure. (auth)

35964 VIBRATIONAL SPECTRA AND NORMAL CO-ORDINATE TREATMENT OF OXAMIDE AND d-OXAMIDE. Sirdeshmukh, Lalitha (Osmania Univ., Hyderabad, India). Curr. Sci. (India), 36: 391-2(Aug. 5, 1967).

The infrared spectra of oxamide and deuterated oxamide were recorded and a normal co-ordinate treatment was carried out to check the assignment of various fundamentals on the basis of potential energy distribution among various symmetry co-ordinates for each normal mode of vibration. Wilson's F-G matrix method was used to evaluate the potential constants with a general quadratic potential function. The calculated frequencies of nine modes are compared with the observed values. (D.H.M.)

35965 HIGH-PRESSURE MASS-SPECTROMETRIC STUDY OF THE REACTIONS BETWEEN D_3^+ AND THE BUTANOLS. Aquilanti, Vincenzo; Galli, Andrea; Volpi, Gian Gualberto (Rome Univ. CNEN, Rome). Ric. Sci., 37: 244-9(Mar. 1967).

The reactions between D_3^+ ions and the butanols were investigated by mass spectrometry, up to a total pressure of 1 torr in the ion-source. Rate constants did not differ significantly from those previously reported for lower alcohols, and were of the order of 10^{-9} cm^3 $molec^{-1}$ sec^{-1}. $C_4H_9OHD^+$ ions were observed at a very low yield, which was however, an increasing function of the total pressure, thus indicating that they were formed in excited states, which decomposed when not deactivated by collision. About 80% of the reaction led to water and butyl ions. The latter, when not deactivated, can also decompose further, the extent of decomposition being a function of their structure. The remaining 20% of the reaction led to oxygenated carbonyl compounds, according to mechanisms which depend on the structure of the alcohols. (auth)

35966 CATALYSIS OF α-HYDROGEN EXCHANGE. VI. ISOBUTYRALDEHYDE-2-d EXCHANGE IN THE PRESENCE OF METHYLAMMONIUM IONS AND VARIOUS BUFFERS. Hine, Jack; Mulders, Julien; Houston, James G.; Idoux, John P. (Georgia Inst. of Tech., Atlanta. Ohio State Univ., Columbus). J. Org. Chem., 32: 2205-9(July 1967).

The kinetics of the catalysis of the dedeuteration of isobutyraldehyde-2-d by methylammonium chloride were studied in the presence of pyridine, 3,4-lutidine, and N-methylmorpholine buffers. Combination of the resultant data with earlier observations shows that a Brønsted plot for the dedeuteration of the iminium ion $Me_2CDCH{=}NHMe^+$ by various bases does not give a straight line. The deviations from linearity, some of which are attributed to steric hindrance, are quite similar to those observed in the Brønsted plot for the direct dedeuteration of isobutyraldehyde-2-d by attack of the same bases. A log–log plot of the rate constants for attack on the aldehyde vs rate constants for attack on the iminium ion gives a close approach to a straight line. This observation supports the assumption that the rate-controlling step in the methylammonium ion catalyzed reaction is attack on the intermediate iminium ion. As expected, the iminium ion is less selective than the aldehyde in donating deuterium to bases. (auth)

35967 ISOBUTYRALDEHYDE AND SECONDARY AMINES. ADDITION AND CATALYSIS OF DEUTERIUM EXCHANGE. Hine, Jack; Mulders, Julien (Georgia Inst. of Tech., Atlanta. Ohio State Univ., Columbus). J. Org. Chem., 32: 2200-5 (July 1967).

Equilibrium constants for the addition of morpholine, piperazine, and dimethylamine to isobutyraldehyde and rate constants for catalysis of the deuterium exchange of isobutyraldehyde-2-d by these three amines and piperidine are reported. Comparison of the results on these four secondary amines, for which a moderately

satisfactory Brønsted plot may be made, with previous results shows that, when steric hindrance is minimized, tertiary amines are more effective catalysts, at a given basicity, for the reaction studied than are secondary amines, which in turn appear to be more effective than primary amines. Although there appears to be little steric hindrance to attack by morpholine and piperidine on isobutyraldehyde-2-d, attack by their N-methyl derivatives appears to be significantly hindered. (auth)

35968 KINETIC STUDY OF PYROLYSIS OF TOLUENE-d_5. Takenaka, Jumpei; Endo, Harumi; Mikuni, Hitoshi; Takahasi, Makoto (Tokyo Univ.). Bull. Chem. Soc. Jap., 40: 1613-16 (July 1967).

The reaction mechanisms for the pyrolysis of toluene were studied with toluene-d_5 of high isotopic purity. The rate constant of pyrolysis of toluene-d_5 in gas phase was determined to be $k = 10^{11.8\pm0.3} \times \exp(-70 \pm 1 \text{ kcal/mol})$ (sec^{-1}) and compared with that of toluene. Hydrogen isotope mixtures produced in the pyrolysis of toluene-d_5 were collected and analyzed by mass spectrometry. Formation of some amount of D_2 was confirmed, and it was concluded that the fission of ring C−D bond was involved to some extent in the pyrolytic reaction of toluene-d_5 at high reaction temperatures. The ratio of rate constants of abstraction type (k_{D-H}/k_{H-H}) was also determined, and the difference of the activation energies between k_{D-H} and k_{H-H} was found to be approximately 14 kcal/mol. (auth)

35969 ROTATIONAL ANALYSIS OF 3200-A ABSORPTION BANDS OF PYRAZINE-^{15}N VAPOR. Innes, K. K. (Vanderbilt Univ., Nashville); Merritt, J. A. J. Mol. Spectros., 23: 280-6(July 1967).

Pyrazine-^{15}N ground-state inertial constants were obtained by analysis of the rotational fine structure of the 0_0^0, 5_0^1, and $6a_0^1$ bands of the $\tilde{A}^1B_{3u}-\tilde{X}^1A_g$ electronic transition. Comparison of the constants with those found earlier for the ordinary pyrazine molecule showed that in the vapor the nitrogen atom is at least 0.05 Å further from the center of mass of the molecule than in the solid. (auth)

35970 GENERAL APPLICATION OF THE COMPLETE ISOTOPIC RULE FOR VIBRATIONAL FREQUENCIES. Brodersen, Svend; Johannesen, Thyra (Univ. of Aarhus, Denmark). J. Mol. Spectros., 23: 293-301(July 1967).

The complete isotopic rule as formerly formulated allows the calculation of n normal frequencies of an "intermediate" compound from a knowledge of 2n normal frequencies of the corresponding "light" and "heavy" compounds. A method is indicated that allows the calculation of n frequencies arbitrarily distributed among the 3n frequencies from the remaining 2n frequencies. A method is indicated to find the influence on the calculated frequencies of errors in the known frequencies. On the basis of examples the conditions are discussed for obtaining physically significant results. (auth)

35971 VIBRATIONAL ASSIGNMENTS FOR CIS-, TRANS-, AND GEM-DICHLOROFLUOROETHYLENES AND DEUTERODICHLOROFLUOROETHYLENES. Craig, Norman C.; Lo, G. Y.-S. (Oberlin Coll., Ohio). J. Mol. Spectros., 23: 307-19(July 1967).

Assignments of the twelve vibrational fundamentals for each of the three isomers of dichlorofluoroethylene and deuterodichlorofluoroethylene were completed by means of an infrared and Raman study of CCl_2CFD and a far-infrared study of CCl_2CFH and of cis- and trans-CFClCClH(D). An internal coordinate representation was found, which made possible transfer between the three isomers of force constants for the out-of-plane modes and thus the prediction of the elusive ν_{12} fundamental for the trans isomer at about 190 cm^{-1} (auth)

35972 ^{17}O NUCLEAR MAGNETIC RESONANCE IN THE URANYL ION. Rabideau, Sherman W. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. J. Phys. Chem., 71: 2747-50(July 1967). (LA-DC-8134).

Measurements were made on the chemical shift of oxygen in the uranyl ion in an acidified aqueous uranyl perchlorate solution. The rate of ^{17}O exchange between UO_2^{2+} and solvent water at various acidities was examined. The ^{17}O resonance absorption signal for the oxygens bonded to uranium was also studied. (J.G.B.)

35973 ^{17}O RELAXATION IN WATER. Garrett, Barry B. (Florida State Univ., Tallahassee); Denison, Arthur B.; Rabideau, Sherman W. Contract W-7405-eng-36. J. Phys. Chem., 71: 2606-11(July 1967). (LA-DC-8211).

Relaxation studies were made on the multilevel spin system ($I = 5/2$) of oxygen-17 in H_2O and D_2O. A general expression for the single relaxation time ($T_1 = T_2$) was obtained for any perturbation describable by a tensor rank L under the conditions of equally spaced levels in the limit of rapid motion. Relaxation times T_1 and T_2 were measured for ^{17}O as a function of temperature in 22% $H_2{}^{17}O$ and in 22% $D_2{}^{17}O$. This enrichment resulted in signal strengths which permitted the nuclear induction tail and the spin echo of ^{17}O in water to be observed for the first time. In addition, line-width measurements of the ^{17}O resonance were obtained with the use of the side-band and the derivative of absorption techniques. Values of T_1 were obtained by the pulse method and also by a saturation procedure with the NMR spectrometer. The value of the effective ^{17}O quadrupole coupling constant which was found to be temperature independent between 5 and 95° is 7.7 ± 1 MHz for both H_2O and D_2O. (auth)

35974 EFFECTS OF IMPURITIES ON THE PRODUCTION OF OXYGEN ATOMS BY A MICROWAVE DISCHARGE. Brown, Robert L. (National Bureau of Standards, Washington, D. C.). J. Phys. Chem., 71: 2492-5(July 1967).

The effects of impurities on the production of O atoms by a microwave discharge were studied in a flow system by measuring with EPR methods the concentrations of $O_2(^3\Sigma_g^-)$, $O_2(^1\Delta_g)$, O, and H atoms as a function of the amounts of H_2O, D_2O, H_2, and N_2 added to the O_2 upstream from the discharge. The effects of varying the microwave power to the discharge and the total pressure were also examined. (auth)

35975 OXALIC COMPLEXES OF PROTACTINIUM(V). Davydov, A. V.; Pal'shin, E. S. At. Energ. (USSR), 22: 389-92 (May 1967). (In Russian).

The solubility of Pa(V) hydroxide in oxalic acid solutions was investigated. The dependence of the solubility of the protactinium hydroxide on the concentration of oxalic acid is related to the characteristics of the protactinium oxalate being formed. For example, the low solubility of the hydroxide in 0.01 to 0.05M oxalic acid solution is explained by the formation of the hydroxy-oxalate complex of Pa with the composition 1:1. The composition of soluble protactinium oxalates, separated from the aqueous solution by acetone, was studied. The ratio $Pa:C_2O_4^{2-}$ in the complex is 1:2. It was shown that the oxides, obtained as a result of the hydrolytic oxidation of Pa from hydrochloric and oxalic acid solutions, contain oxalate and chloride ions. (tr-auth)

35976 RESULTS OF THE X-RAY SPECTRAL ANALYSIS OF Ce, Pr, AND Sm IN SILICON, GERMANIUM, ALUMINUM, BERYLLIUM, AND MAGNESIUM COMPOUNDS. Vainshtein, E. E.; Bril, M. N.; Staryi, I. B.; Gladyshevskii, E. I.; Kripyakevich, P. I. (Inst. of Inorganic Chemistry, Novosibirsk, USSR. Lvov State Univ.). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 644-8(Apr. 1967). (In Russian).

Experimental studies of x-ray L_{III}-spectra of Ce, Pr, and Sm absorption in compounds containing Si, Ge, Al, Be, and Mg showed that in such compounds rare earths appear as trivalent elements. Analysis of the five rare earth spectra in germanides and silicides indicated similarity of the inter-atomic reactions and the absence of rare earth elements in anomalous valency states in such compounds as Ce_5Si_3 and Ce_5Ge_3 in which the presence of two types of rare earth atoms was found in nonequivalent crystallographic positions. (R.V.J.)

35977 INVESTIGATION OF THE HYDROGEN BASIC EXCHANGE OF AROMATIC CH BONDS OF SOME NITROGEN-CONTAINING HETEROCYCLES, THEIR N-OXIDES, AND TERTIARY SALTS. Tupitsyn, I. F.; Zatsepina, N. N.; Kirova, A. V. (State Inst. of Applied Chemistry, Leningrad). Isotopenpraxis, 3: 136-40(Apr. 1967). (In Russian).

The kinetics of the hydrogen isotopic exchange was studied for the nitrogen-containing heterocycles pyridine, pyrimidine, quinoline, γ,γ'-dipyridyl, pyridine-N-oxide, iodine methylate of pyridine, etc., in alcoholic solutions of potassium ethylate. The rate constants of hydrogen isotopic exchange are considered with respect to the position of the hydrogen atoms on the ring. The mechanism of the reaction is discussed. (auth)

35978 A COMPREHENSIVE STUDY OF THE METAL CHELATES OF THE AQUEOUS URANIUM(IV) ION. Carey, George Henry. Chicago, Illinois Inst. of Tech., 1966. 115p. Thesis.

A procedure is outlined for the preparation of pure standard U(IV) chloride solution containing a known amount of excess acid, and potentiometric equilibrium data are reported for the formation of U(IV) chelates of N,N,N',N'-ethylenediaminetetraacetic acid (EDTA), 1,2-cyclohexanediaminetetraacetic acid (CDTA), nitrilotriacetic acid (NTA), N-hydroxyethyliminodiacetic acid (HIMDA), iminodiacetic acid (IMDA), N-hydroxyethylethylenediaminetriacetic acid (HEDTA), and diethylenetriaminepentaacetic acid (DTPA). The tendencies of these metal chelates to form hydroxo derivatives and olated polynuclear species are determined, and the corresponding equilibrium constants are calculated. The relative stabilities are correlated with the tendencies of the aqueous chelates to undergo hydrolysis and dimerization. Although the U(IV) chelates are more stable and show a greater tendency to hydrolyze than do the cor-

responding Th(IV) chelates, the U(IV) chelates show less tendency to form polynuclear species than do those of Th(IV). Potentiometric studies are reported of mixed ligand uranium(IV) chelate formation with N,N,N,N′-ethylenediaminetetraacetic acid (EDTA) and nitrilotriacetic acid (NTA) as primary ligands. Secondary ligands studied are disodium 1,2-dihydroxybenzene-3,5-disulfonate (Tiron), 1,8-dihydroxynaphthalene-3,6-disodium sulfonate (CS), pyrocatechol (PY), salicylic acid (SA), 5-sulfosalicylic acid (SSA), iminodiacetic acid (IMDA), potassium acid phthalate (KHP), and 8-hydroxy-5-quinolinesulfonic acid (HQS). When the stoichiometry ratios of the two ligands are such that the coordination vacancies of the metal ion are completely filled, the mixed ligand chelates thus formed are usually more stable towards hydrolysis than the analogous U(IV) chelates containing only one type of ligand. The results obtained with a wide variety of mixed ligand chelates of U(IV) indicate that they may be divided into several classifications, depending on the order in which the ligands coordinate with the metal, on whether or not hydrolysis steps take place, and on whether the system disproportionates into a mixture of complexes each containing one type of ligand. For the mixed ligand chelate systems containing EDTA, combination with the primary ligand is complete before combination with the secondary ligand takes place. Mixed ligand chelates containing NTA are generally less stable, and in most of the systems studied cannot be detected by titrimetric methods. However, the formation of a mixed ligand NTA chelate with HQS as the secondary ligand was detected. When Tiron is the secondary ligand and NTA is the primary ligand, a mixture of two simple chelate compounds are formed rather than a mixed ligand chelate. The relative values of the equilibrium constants for formation of the mixed ligand chelates with the U(IV)-EDTA chelate are CS > Tiron > PY > SSA > HQS > IMDA ≫ KHP. Calculation of the corresponding stability constants indicates that the mixed ligand chelates of U(IV) are more stable than those of Th(IV) by 1 to 3 log K units. (Disser. Abstr.)

35979 ELECTRICAL CONDUCTION AND DEFECTS IN KH_2PO_4 AND KD_2PO_4. Perrino, Charles Thomas. Tempe, Ariz., Arizona State Univ., 1967. 94p.

Thesis.

The conductivities of the following systems were investigated: KH_2PO_4-$KHSO_4$ and KD_2PO_4-$KDSO_4$. In all cases the conductivity follows an equation of the type $\sigma = \sigma_1 \exp(-E_1/RT) + \sigma_2 \exp(E_2/RT)$. The conductivity of pure KH_2PO_4 was found to be extremely low having a value of 5×10^{-11} at 25°C. For the a-axis of the pure material the conductivity can be represented by the equations: $\log \sigma = -1.17 - 2760/T$, T < 175°C and $\log \sigma = 2.00 - 3920/T$, T > 175°C; and for the deuterated material: $\log \sigma = -1.60 - 2690/T$, T < 102°C and $\log \sigma = 3.49 - 4150/T$, T > 102°C. Defects analogous to those responsible for conduction in ice are proposed for KH_2PO_4. The basis for this is a consideration of the hydrogen bond network in KH_2PO_4. In the doped crystals each HSO_4^- ion yields an L defect (a hydrogen bond without a proton) and the conductivity shows a linear dependence on the concentration of HSO_4^-. Calculations of the proton jump frequency indicates that the reaction HSO_4, L–HSO_4 + L is the most important for the doped crystal. Both L defects and ions ($H_3PO_4^+$, HPO_4^-) are necessary for conduction. At low temperatures the migration and formation of L defects controls the conductivity. Above 175°C (102°C for KD_2PO_4) the large number of L defects in the crystal require the simultaneous formation of ions according to the reaction $2\ H_2PO_4 \rightarrow H_3PO_4^+ + HPO_4^-$, thus accounting for the increase in activation energy at high temperature. Very little difference was noted between the conductivity of KH_2PO_4 and KD_2PO_4. One exception was the lowering of the temperature at which the formation of ions becomes an important factor in conduction. Infrared and neutron inelastic scattering results of other authors are used to explain this difference. A possible mechanism for conduction is proposed considering sequence of intrabond and interbond jumps and the crystal structure. To prevent dehydration of KH_2PO_4 as the crystal was heated, it was necessary to measure the vapor pressure defined by the following equilibria: KH_2PO_4 (saturated solution) → $KH_2PO_4 + H_2O$ (gas), $KH_2PO_4 \rightarrow KPO_3 + H_2O$ (gas) T < 235°C, and $2\ KH_2PO_4 \rightarrow K_2H_2P_2O_7 + H_2O$ (gas) T > 235°C. The results were combined with previously reported measurements to define the field of existence of KH_2PO_4. (Disser. Abstr.)

35980 EFFECT OF INTRAPARTICLE DIFFUSION ON SINGLE STEP DEUTERIUM–HYDRIDE EXCHANGE REACTIONS. Dwyer, Francis Gerard. Philadelphia, Univ. of Pennsylvania, 1966. 173p.

Thesis.

Theoretical analysis showed the effect of intraparticle diffusion on a complex chemical reaction to be a distortion of the product distribution rather than a retarding effect. This distortion of product distribution can lead to an erroneous apparent reaction mechanism if the diffusion parameters are ignored. This research is aimed at experimentally demonstrating this effect and extracting effective diffusion parameters from the experimental results. The deuterium exchange of neopentane was selected as the complex chemical reaction to be studied. This reaction, when catalyzed by Pd, was reported to be a single step exchange mechanism. The reaction was carried out in a batch system using Pd supported on microporous silica-alumina spheres as the catalyst. The reactants and products were continuously monitored by mass spectrometry. Experimental results showed product distributions with varying degrees of deviation from that predicted for the known single-step exchange mechanism. The amount of deviation was consistent with the amount of diffusional resistance present. The diffusional resistance was varied by changing catalyst pore diameter, catalyst particle size, and reaction temperature. Since product distributions that deviate from that of a single step exchange mechanism are indicative of multiple step exchange, the experimental results substantiate the predicted mechanistic distortion. Values of the effective intraparticle diffusion coefficients, extracted from the experimental data, were in relatively good agreement with those obtained from the H_2-N_2 diffusion method. In general the values obtained from the reaction data were about one-half of those from the H_2-N_2 method. This research demonstrates techniques for studying chemical reaction mechanisms when interfering physical parameters may be present. It also provides guidelines for separating the effects of physical parameters, such as diffusional and sorption effects, which may be effecting the kinetics of a reaction. (Disser. Abstr.)

35981 HYDROGEN–DEUTERIUM EXCHANGE OF POLYPEPTIDES. Leichtling, Benjamin Hersch. Evanston, Ill., Northwestern Univ., 1966. 133p.

Thesis.

Hydrogen–deuterium exchange in model peptides containing nonbonded NH groups was found previously to be general acid and base catalyzed and to have an activation energy of 20 kcal/mole. Based on results on the exchange of acetylglycine ethyl ester and chloroacetylglycine ethyl ester in (1:1)-D_2O-dioxane and the results of a number of other workers, a mechanism was proposed to account for the effects observed in the model compounds. From considerations of inductive, steric, and solvent effects, it was shown that the meaningful parameters for comparing exchange results of the model compounds are the minimum rate constant and the pD at which the rate constant is minimal, or correctly calculated values of the acid and base constants. The proposed mechanisms indicates the correct procedures for considering the effects of perturbants on the rate of exchange of the model compounds. Random coil poly-L-lysine in (1:1)D_2O-dioxane exchanged at the same rate as did the smaller, free NH compounds. The effect of the cationic ϵ amino group was easily understandable on the basis of the proposed mechanism. The exchange of poly-L-glutamic acid, a common helix standard, was also studied in the mixed solvent. The near infrared spectrum of the helical polymer showed a doublet at 1.53 and 1.57 μ, while poly-L-lysine and the smaller free NH models showed a single peak at 1.50 μ in the same solvent. Both (D^+) and (OD^-) catalysis was found for poly-L-glutamic acid in a pD region in which titration, optical rotation, and viscosity measurements indicated essentially complete helix. The exchange of the helical polymer was first-order and complete exchange was ultimately attained at all pD's. The activation energy between 25 and 61°C was 27 kcal/mole, as compared to 19 to 23 kcal/mole for the two free NH esters in the same solvent. The exchange of the helix was also catalyzed by the acidic and basic forms of a number of halogenated acetic acids. Therefore, for as many variables as were tested, the exchange of the helix was affected by the same factors as affect the exchange of the free NH compounds. Although the exchange of the helix was affected by all of these factors, at pD_{min} the rate of exchange was about 1,000 times slower than that of the model compounds. Therefore, the helix decreased the rate greatly. This decrease cannot be attributed to the hydrogen bonding per se because, due to the helix, the peptide NH's are not completely accessible to the solvent. This could have an extremely large effect on the rate. Although the rate at the minimum was slow, the usual pD dependency of the exchange would result in essentially instantaneous exchange for the helix at neutral pD. In the region of the γ-carboxyl ionization and the helix-to-coil transition, the rate was greatly increased over that expected for the exchange of the helix. The results indicate the extreme importance of the local acid and base and solvent environment on the rate of exchange. Certainly, at neutral pH, the slowly-exchanging and nonexchanging protein hydrogens are somehow further constrained by the protein environment, in addition to showing any effects due to helicity. (Disser. Abstr.)

35982 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF URANYL FLUORIDE. Grant, Albert Edgar; Brooks, Lionel Hepworth (to United Kingdom Atomic Energy Authority). British Patent 1,075,233. July 12, 1967. Filed Mar. 26, 1964.

A process for the production of UO_2F_2 powder consists of introducing gaseous UF_6 into a mixture of liquid HF and H_2O with the proportions of the HF and H_2O in the mixture being such that substantially all the U separates out as a precipitate of UO_2F_2. The mixture should comprise at least 80 wt % HF. (B.L.M.)

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Refer also to abstracts 36626 and 37622.

35983 (AAEC/TM-373) RADIATION CHEMISTRY OF ACETYLENE: A REVIEW. McLaren, K. G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Feb. 1967. 21p. Dep.

Literature on the high-energy radiation chemistry of acetylene is reviewed. Radiolysis of pure acetylene produces mainly polymeric products (polyacetylenes) with a radiation yield G ($-C_2H_2$) of about 70. Small quantities of benzene [G(benzene) ≈7 to 15] are also formed. Polyacetylenes are noncrystalline, insoluble, and stable at temperatures up to around 300°C. They were reported to take up as much as 30 wt % oxygen at room temperature. Some discrepancies are found in effects of experimental variables (temperature, pressure, radiation intensity, and the presence of inert gases or radical scavengers) as reported by different workers. The relative contributions to the radiation mechanisms from ionized, excited, and free-radical species are not well understood. Little information is available about radioinduced reactions of acetylene with other materials such as hydrogen, sulfur dioxide, ammonia, and oxygen. Acetylene–oxygen mixtures were reported to yield polyacetylenes possessing carbonyl, carboxylic, and other functional groups. These polymers were soluble in polar solvents. Some systems of potential interest for radiation research are discussed. (auth)

35984 (AEET-271) STUDIES ON THERMAL ANNEALING OF NEUTRON-IRRADIATED TRIS-DIPYRIDYL COBALT(III) PERCHLORATE: REDISTRIBUTION OF ELECTRONS AMONG THE DONORS. Nath, Amar; Vaish, S. P. (Atomic Energy Establishment, Trombay (India)). 1966. 15p. Dep.

Thermally treated and untreated anhydrous samples of tris-dipyridyl Co(III) perchlorate were hydrated at 30° in air at a relative humidity of 93%. Some of them were chilled at −78° while others were kept at 30° for a prolonged period before chilling at −78°. The chilled samples were neutron irradiated at −78°. Thermally treated samples chilled immediately after hydration exhibit a much faster rate of thermal annealing as compared to the latter and to the trihydrate. These observations have been interpreted on the basis of the "variable depth electron donors–isotopic exchange" model which postulates an annealing rate proportional to the free electron density. Evidence is presented for the creation of electron traps and electron-hole "recombination centers" during thermal treatment of the anhydrous form and for populating of the electron traps with electrons to form shallow donors during hydration through exo-electron emission. Hence, in the freshly hydrated samples kept at 30° for prolonged periods before chilling and irradiation, a considerable amount of depopulation of the shallow donors takes place resulting in a slower rate of post-recoil thermal annealing. In contrast, the hydrated complex prepared by hydrating the untreated anhydrous sample exhibits a faster rate of annealing on storage at 30° after hydration and prior to irradiation as compared to the samples chilled immediately after hydration. For the trihydrate it has been shown that the electron traps constituted by the crystal imperfections are largely filled up with electrons during crystallization from aqueous solution. However the process of filling up continues slowly during storage of $Co(dipy)_3(ClO_4)_3 3H_2O$ at 30°C (or at higher temperature). Consequently the stored samples show a faster rate of annealing as compared to the freshly prepared ones. (auth)

35985 (CEA-R-3153) PRODUCTION DE L'IODE 131 PAR VOIE SECHE A PARTIR DE TELLURE ELEMENTAIRE IRRADIE A LA PILE. 1 ERE PARTIE. ETUDES DES CONDITIONS POUR OBTENIR L'EMANATION DE L'IODE ET LE CAPTER. (Iodine-131 Production by a Dry Method Using Reactor-Irradiated Elementary Tellurium. Part I. Conditions for Obtaining Iodine Emanation and its Capture). Bardy, Andre; Beydon, Jacqueline (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr. 1967. 16p. (In French). Dep.

A dry method was developed for separating ^{131}I obtained by reactor-irradiation of elementary tellurium. It involves heating the irradiated tellurium to about 400°C. It is relatively simple to treat 400 g of tellurium and to collect 90% of the ^{131}I thus formed. (auth)

35986 (COO-1273-4) STUDIES IN RADIATION CHEMISTRY. Final Report. Gillis, Hugh A. (Western Reserve Univ., Cleveland, Ohio. Dept. of Chemistry). May 31, 1967. Contract AT (11-1)-1273. 29p. Dep. CFSTI.

In order to understand the role of reactive solutes used in the radiation chemistry of liquids, a study was made using ethane as solvent. The yields of the major products in the gamma radiolysis of pure ethane (hydrogen, methane, acetylene, ethylene, propane, and n-butane) were in reasonably good agreement with previous values. Thirteen other products with a total G of about 0.16, ranging from propylene to octane, were identified. From results of the irradiation of solutions of C_2D_6 in C_2H_6 and C_2D_4 in C_2H_4 it seems clear that thermal hydrogen atoms are produced in the radiolysis of liquid ethane and that they are scavenged by added or radiolytically generated ethylene. The effects of oxygen and nitrous oxide on the main product yields in irradiation of ethane solutions were studied. (D.H.M.)

35987 (DP-1114) PROPERTIES OF THULIUM METAL AND OXIDE. Smith, P. Kent; Keski, James R.; Angerman, Carl L. (comps.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). June 1967. Contract AT(07-2)-1. 40p. Dep. CFSTI.

Properties of thulium metal and thulium oxide were surveyed to establish specifications for reactor target materials for experimental production of ^{170}Tm for isotopic power source applications. Radiation characteristics and chemical, thermophysical, and mechanical properties are presented that are pertinent to the use of activated targets without reprocessing after irradiation. (auth)

35988 (EUR-3496.f) PREPARATION DE MOLECULES MARQUEES PAR IRRADIATION GAMMA. Rapport Final. (Preparation of Labelled Molecules by Gamma Irradiation. Final Report.). Constant, R.; Lecocq, R.; Provoost, F.; Vasilescu, P. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). July 1967. Contract 085-64-11 RISB. 76p. Dep.

Under the influence of gamma irradiation of the CO_2-CH_4 mixture, various substances form, which can be divided into three phases: the condensable phase at −78°C, containing some twenty substances with different organic functions; the noncondensable phase at −78°C, in which the main substances formed are ethane and carbon monoxide; and the polymer phase of the "polyketene" type. Gas-phase chromatography was used for identifying and analyzing the substances formed, which are condensable and noncondensable at −78°C. Infrared spectroscopy was employed for analyzing the polymer fracture. When using $^{14}CO_2$, the labeled compounds were detected by means of an ionization chamber together with the chromatography equipment. Two of the substances formed during radiolysis of the CO_2-CH_4 system are of particular interest, i.e., acetone and methylethylketone, which represent about 75% of the phase condensable at −78°C. On the basis of this observation, the influence of certain parameters (molar ratio, pressure, total dose absorbed, temperature, and presence of solid or gaseous additives) on the radiolysis of the $CO_2 + CH_4$ mixture was studied. The ketone formation yields were improved; they followed an ascending curve in the order of irradiation techniques shown below: homogeneous-phase irradiation: low pressure (<20 atm); homogeneous-phase irradiation: high pressure (>40 atm); irradiation in the presence of solid additives (low pressure); and irradiation in the presence of gaseous additives (high pressure). An optimum acetone and methylethylketone yield was obtained by irradiating, at room temperature and a dose of 10 Mrads, a CO_2-CH_4 mixture (molar ratio 3:1) at a partial pressure of 40 atm and in the presence of 50% xenon. When considering the mechanisms governing the formation and radiolysis of ethane and acetone, radiolysis of the latter compound was shown to be very substantial. The possibility of applying this study to the production of acetone is prompted by irradiation of the $^{14}CO_2-CH_4$ mixture. (auth)

35989 (N-67-18125) THERMAL CONDUCTIVITY STUDIES OF HIGH POLYMERS. Final Report. Kline, D. E. (Pennsylvania State Univ., University Park). [1966]. 4p. (NASA-CR-81782). CFSTI.

Analyses continued on thermal conductivity of various polymer systems, some of which were altered by nuclear radiation for purposes of radiation effects studies. Emphasis was directed toward documenting the series of polymer thermal analysis report. (STAR)

35990 (RRL-2310-208) RADIATION RESEARCH LABORATORIES QUARTERLY REPORT, APRIL 1, 1967–JUNE 30, 1967. (Mellon Inst., Pittsburgh, Pa. Radiation Research Labs.). June 30, 1967. Contract AT(30-1)-2310. 22p. Dep. CFSTI.

Research progress is reported on: EPR-transient radicals in aqueous solutions, pulse radiolysis studies of the reaction of OH radicals with nitromethane, pulse radiolytic studies of oxygen-containing transients, photochemical determination of relative rate constants for hydroxyl radical and solvated electron reactions, electron scavenging in irradiated cyclohexane solutions,

effect of temperature and phase on ratios of disproportionation to combination of alkyl radicals, pressure dependence of $G(N_2)$ from propane-nitrous oxide mixtures, radioinduced hydroxylation of anisole in dilute aqueous solution, hydrolysis of nitrosubstituted aryl sulfates, Meisenheimer complexes, $Hg(^1P_1)$-photosensitized reactions, mass spectrometric studies of discharge phenomena, formation of phenol in irradiated $N_2O-C_6H_6$ solutions, theoretical studies of the structure of the PF_4 radical, calculations of ESR spectra, and of ^{18}O isotopic dilution studies in biological systems. (M.C.G.)

35991 BEHAVIOR OF STABILIZED PVC DURING ITS IRRADIATIVE COPOLYMERIZATION WITH VINYL MONOMERS. Langner, H.; Zeppenfeld, G.; Bartl, A. (Inst. for Metal Physics and High Purity Metals, Dresden). Plaste Kaut., No. 2, 76-8 (1966). (In German).

The kinetics of surface grafting of acrylonitrile and styrene to γ-irradiated stabilized PVC (polyvinylchloride) was studied. The PVC samples stabilized with lead stearate, tribasic lead sulfate, dibutyl-tin-methylene-bis-thioglycolate, and dibutyl-tin-octylidine-bis-thioglycolate were first irradiated for 1 hr with 4.3×10^5 R/hr using a ^{60}Co γ source and then held for 0 to 120 minutes in monomeric acrylonitrile or styrene at 50°C. The PVC film samples were 0.1 to 0.3 mm thick. The PVC stabilized with lead compounds grafted 9 to 16 wt % of the monomers while those stabilized with the tin compound grafted up to 7 wt % of monomers. The electron spin resonance examination revealed half-life periods of 3 hr for PVC stabilized with Sn-compounds, and 30 hrs for non-stabilized PVC. (JPRS)

35992 POLAROGRAPHIC STUDIES OF CHANGES INDUCED IN POLYMERS BY RADIATION. Sallichuk, E. K.; Nagornaya, L. L.; Bezuglyi, V. D. Radiokhimiya, 9: 221-5(1967). (In Russian).

Disks of polystyrene (PS) or poly(methyl methacrylate) (PMM) 1 to 1.5 mm thick were given varying gamma doses at a dose rate of ~1200 rad/sec. The irradiated samples were placed in thermostated bottles at 25°C and covered with a definite amount of mixed solvent such as 40% benzene + 60% methanol, or 40% benzene + 60% heptane (the methane and heptane were added to decrease the rate of dissolution of the polymer). After a given time part of the solution was poured off for analysis. The content of dissolved polymer in the sample was estimated polarographically from the change in height of the oxygen maximum on adding 2 ml of 0.1M solution of KI to 0.2 ml of solution to be analyzed. Destruction of polystyrol molecules was observed at a dose of 1 to 5×10^6 rads. On irradiation at higher doses of 5×10^6 rads, the polystyrene disks swelled and became practically insoluble. This behavior can be explained by the formation of crosslinks. The PMM disks showed an increase in solubility after irradiation due to destruction of the polymer structure. Measurement of the molecular weight of the PMM polymer as a function of gamma dose showed a decrease in molecular weight by more than a factor of 10 on increasing the irradiation dose from 0.8 to 10×10^6 rads. The same behavior was observed on irradiating these polymers with ultraviolet light. (TTT)

35993 INVESTIGATION OF IRRADIATED BORON NITRIDE BY ELECTRON PARAMAGNETIC RESONANCE. Khusidman, M. B.; Sharupin, B. N. Radiokhimiya, 9: 279-80(1967). (In Russian).

A BN sample irradiated with a gamma dose of 1.5×10^8 R showed a microwave absorption consisting of 10 lines of a superfine structure with a distance of approximately 7.1 ϵ between the lines. The total line width was about 80 ϵ, and the g-factor was equal to 2.0030 ± 0.0002. The intensity did not exceed 10^{18} centers/g. The centers responsible for the absorption were identified as positively charged, nitrogen-atom vacancies, which have captured an electron and become similar to F-centers in alkali halide crystals. The superfine structure is apparently due to delocalization of the unpaired electron, captured by the nitrogen vacancy, among the three surrounding boron atoms. It is shown that the superfine structure is due to the isotropic interaction of the unpaired electron with the magnetic moments of the three boron nuclei. Annealing for 15 minutes at 1000°C led to a disappearance of the EPR signal. Neutron irradiation of hexagonal boron nitride led to the appearance of either a new free radical or a new unidentified activation center. (TTT)

35994 RADIATION CHEMISTRY OF DICARBOXYLIC ACIDS IN THE SOLID STATE. I. RADIOLYSIS OF MALONIC ACID IN THE SOLID STATE. Hosaka, Akio; Sugimori, Akira; Genka, Tsuguo; Tsuchihashi, Gen-ichi (Japan Atomic Energy Research Inst., Tokyo). Bull. Chem. Soc. Jap., 40: 1799-1803(Aug. 1967).

The radiolysis of solid malonic acid by ^{60}Co γ rays was studied in vacuo at −196°C, −78°C, and room temperature. All the products were measured after dissolving the irradiated malonic acid in water. The main products were carbon dioxide with G = 4.4 and acetic acid with G = 4.5, as was determined by the reverse isotope dilution analysis. The yields of the other products (hydrogen, carbon monoxide, methane, ethane, and carbonyl compounds) were very low. These facts revealed that the reaction

$$CH_2\begin{matrix}COOH\\COOH\end{matrix} \xrightarrow{\gamma\text{-rays}} CH_3COOH + CO_2$$

takes place selectively. The mechanism of the reaction is discussed with reference to the results of product analyses and ESR. (auth)

35995 RADIATION CHEMISTRY OF DICARBOXYLIC ACIDS IN THE SOLID STATE. II. ^{13}C ISOTOPE EFFECTS IN THE RADIATION-INDUCED DECARBOXYLATION OF MALONIC AND SEVERAL ALIPHATIC DICARBOXYLIC ACIDS. Hosaka, Akio; Sugimori, Akira; Tsuchihashi, Gen-ichi (Japan Atomic Energy Research Inst., Tokyo). Bull. Chem. Soc. Jap., 40: 1803-6(Aug. 1967).

The ^{13}C isotope effects in the gamma-induced decarboxylation of several dicarboxylic acids were investigated. Malonic acid showed a ^{13}C isotope effect of about 2%; this is much greater than those of monocarboxylic acids. The greater isotope effect of malonic acid is attributed to the intramolecular competition of the C-carboxyl bond rupture. Succinic, adipic, and pimelic acid, in which the intramolecular interaction of two carboxyl groups can be expected, gave large isotope-effect values, whereas glutaric and sebacic acid, in which such an effect may be expected to be small, showed lower isotope effects. Analogously, maleic acid (cis isomer) showed a larger isotope effect than did fumaric acid (trans isomer). (auth)

35996 RADIOLYSIS OF PERFLUORODIMETHYLCYCLOHEXANE. III. FISSION FRAGMENTS. Scott, Thomas H.; Wethington, John A. Jr. (Univ. of Florida, Gainesville). Trans. Amer. Nucl. Soc., 10: 159(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35997 RADIOLYSIS OF PERFLUORODIMETHYLCYCLOHEXANE. II. REACTOR RADIATIONS. Scott, Thomas H.; Wethington, John A. Jr. (Univ. of Florida, Gainesville). Trans. Amer. Nucl. Soc., 10: 158(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35998 RADIOLYSIS OF PERFLUORODIMETHYLCYCLOHEXANE. I. GAMMA PHOTONS. Scott, Thomas H.; Wethington, John A. Jr. (Univ. of Florida, Gainesville). Trans. Amer. Nucl. Soc., 10: 157-8(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

35999 ECONOMIC ANALYSIS OF A CHEMONUCLEAR PLANT PRODUCING HCN AND NH_3 FOR AGRICULTURAL USE. Elliott, Donald M. (Stanford Research Inst., Menlo Park, Calif.). Trans. Amer. Nucl. Soc., 10: 45-6(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36000 FISSIOCHEMICAL REACTION OF NITROGEN WITH CARBON MONOXIDE. Miller, R. I. (Aerojet-General Corp., San Ramon, Calif.). Trans. Amer. Nucl. Soc., 10: 46-7(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36001 MINIMUM-COST POLICY FOR THE PRODUCTION OF RADIOACTIVE ISOTOPES. Eckhoff, N. D.; Fan, L. T.; Kimel, W. R. (Kansas State Univ., Manhattan). Trans. Amer. Nucl. Soc., 10: 47-8(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36002 ANALOG SIMULATION OF CESIUM PRODUCTION. Rothbart, Michael A.; Galanter, Leonard (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 10: 48-9(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36003 OPTIMIZING SCHEDULES AT THE TRU–HFIR COMPLEX TO MAXIMIZE ^{249}Cf OR ^{252}Cf AS ALTERNATIVE PRODUCTS. Bigelow, John Ealy (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 93(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36004 SECONDARY ELECTRONS IN THE RADIOLYSIS OF CYCLOHEXANE. Sato, Shin; Terao, Terumi; Kono, Michiyuki; Shida, Shoji (Tokyo Inst. of Tech.). Bull. Chem. Soc. Jap., 40: 1818-22(Aug. 1967).

Carbon dioxide and sulfur hexafluoride were used as electron

scavengers in the γ radiolysis of cyclohexane. The dependence of $G(H_2)$ on the concentrations of additives can be interpreted satisfactorily in terms of diffusion-controlled reactions between electrons and the additives. A simple calculation was made using a function proportional to $r^2 \exp(-\alpha r^2)$ for the initial distribution of secondary electrons. The distribution constant α and the value of G(electrons) were adjusted to make the calculated curve of $G(H_2)$ vs. scavenger concentration coincide with the observed one. The average initial separation of the secondary electron from the parent positive ion was found to be about 50 Å, and G(electrons) = 3. (auth)

36005 EFFECT OF HYDROGEN ATOM AND ELECTRON SCAVENGERS ON THE GAS-PHASE RADIOLYSIS OF AMMONIA. Nishikawa, Masaru; Shinohara, Nobuyoshi; Matsuura, Niro (Tokyo Univ.). Bull. Chem. Soc. Jap., 40: 1993(Aug. 1967).

The effects of various additives on the γ radiolysis of ammonia at ~50 cmHg at 20°C were studied. It was found that $G(H_2)$ fell from 4.3 to 2.5 at N_2O concentrations greater than 5 mol%; $G(H_2)$ was 0.64 in the presence of CCl_4 above 2 mol%; and $G(H_2)$ was between 0.70 and 0.82 in the presence of C_2H_4 or C_2H_6 over the concentration range 1.5 to 3.8 mol%. The hydrogen yield for the radiolysis of ammonia and the hydrocarbons gradually increased with ammonia concentration. (D.H.M.)

36006 AROMATIC ORDERED COPOLYAMIDES FOR TEMPERATURE-RESISTANT FIBERS. Preston, J.; Smith, R. W.; Stehman, C. J. (Chemstrand Research Center, Inc., Durham, N. C.). J. Polym. Sci., Part C, No. 19, 7-15(1967).

Fibers were spun from five different wholly aromatic ordered copolyamides. Each polymer contained units derived from aminobenzoic acids, arylene diamines, and arylene diacids. Structural differences in the ordered copolyamides were made by variations in combinations of para- and meta-phenylene units, 2,6-naphthalene units, and 4,4'-biphenylene units. Tensile properties of the fibers were obtained at standard conditions, at elevated temperatures, and after heating at 300°C in air. All of the fibers had tenacities of about 6 g/den and all were crystalline after drawing. Ease of crystallization, initial modulus, elongation, and retention of tensile properties at elevated temperatures in air were, in general, consistent with variations in the structure of the polymers. Fiber properties were retained to a high degree at temperatures up to 400°C, and fibers heat-aged at 300°C showed remarkable retention of tensile properties. Radiation resistance (γ source, 2.92×10^5 RADS/hr) of these fibers was good and resistance to ultraviolet light appeared to be better than that of unstabilized nylon 66. (auth)

36007 FIBERS OF THERMALLY STABLE ORDERED HETEROCYCLE–AMIDE COPOLYMERS. Preston, J.; Black, W. B. (Chemstrand Research Center, Inc., Durham, N. C.). J. Polym. Sci., Part C, No. 19, 17-27(1967).

Thermostable fibers were spun from several ordered heterocycle–amide copolymers. Tenacities up to 8 g/den at standard conditions were obtained. The polymers were prepared by condensation of arylene diacid chlorides with aromatic diamines containing preformed heterocyclic units of types known to be thermally stable (oxadiazole, thiazole, and bithiazole). Fiber tensile properties were determined at temperatures up to that at which the fiber failed. Each fiber had a zero strength temperature of over 515°C in nitrogen, and each had appreciable strength at 400°C. In general, the fiber showed excellent retention of tenacity after heat-aging for long periods of time at 300°C in air. An oxiadizole–amide fiber retained three-fourths of its original tenacity after 168 hr under these conditions. All fibers were very resistant to γ and uv radiations. (auth)

36008 A NEW HIGH TEMPERATURE FIBER, ITS PROPERTIES AND PERFORMANCE. Weiss, J. O.; Morgan, H. S.; Lilyquist, M. R. (Chemstrand Research Center, Inc., Durham, N. C.). J. Polym. Sci., Part C, No. 19, 29-39(1967).

Fibers of ordered aromatic copolyamides were found exceptionally resistant to degradation at high temperatures. A typical member of this class of fibers was selected for presentation to illustrate the high performance characteristics of these fibers. The selected polymer, containing ordered aromatic components with meta- and para-benzanilide linkages, was spun into fibers from solution. The excellent heat stability of the fiber is demonstrated by its retention of strength at high temperatures and after prolonged exposures to elevated temperatures. Among other outstanding properties are its balance of tensile properties, resistance to hydrolysis and chemical degradation, high dielectric strength, and stability in ionizing radiation. Fabrics constructed from this fiber have good flexibility and abrasion resistance at elevated temperatures. The combination of high strength and durability at high temperatures should gain acceptance for this fiber in a variety of industrial and military applications including hot gas filter bags, belting, heat-resistant clothing, electrical insulation in motors and transformers, and fabrics for parachute packs and harnesses. (auth)

36009 RADIOLYSIS OF ALIPHATIC ALCOHOL GLASSES. Kosa Somogyi, Istvan. KFKI (Kozp. Fiz. Kut. Int.) Kozlem., 15: 195-206(1967). (In Hungarian).

In C_1 to C_3 aliphatic alcohols irradiated with ^{60}Co gamma rays at 77°K trapped electrons are formed, which exhibit a broad optical absorption in the visible range. The absorption maximum was observed for the alcohols in glassy state at about 520 nm, except for 2-propanol, which shows maximum absorption at 575 nm. Suitably oriented OM groups act as trapping sites for electrons. The relationship between the electron traps and the glass structure could be revealed by parallel electrical conductivity and optical measurements. The radiolysis of deuterated methanol and ethanol was also studied. (auth)

36010 ESR STUDY OF THE RADICAL YIELD FROM THE γ RADIOLYSIS OF ORGANIC COMPOUNDS. Ero, Janosne. KFKI (Kozp. Fiz. Kut. Int.) Kozlem., 15: 207-21(1967). (In Hungarian).

The radical products in the γ radiolysis of organic compounds were investigated by the ESR method. The type of the radicals formed could be identified and the radiochemical yield determined for four groups of compounds, each characterized by a different type of ring, namely, aromatic, saturated, both types, and aromatic with aliphatic chain. The departure from additivity, the extent of energy transfer, was studied by making use of the known yields of various components and in a few cases the limitations of the usefulness of the method could be established. (auth)

36011 SPATIAL DISTRIBUTION OF H ATOMS RELEASED BY γ IRRADIATION AT 77°K. Zador, Erika. KFKI (Kozp. Fiz. Kut. Int.) Kozlem., 15: 223-7(1967). (In Hungarian).

The spatial distribution of H atoms obtained by γ irradiation of solid aqueous solutions of perchloric acid was investigated at 77°K by the ESR method. Both the theoretical considerations and the experimental data indicated the spatial distribution of H-atoms formed on irradiation with small doses to be inhomogeneous. (auth)

36012 YIELD OF SCAVENGEABLE HYDROGEN ATOMS, ELECTRONS, AND POSITIVE CHARGES IN THE RADIOLYSIS OF LIQUID n-HEXANE. Rajbenbach, L. A.; Kaldor, U. (Soreq Nuclear Research Center, Yavne, Israel). J. Chem. Phys., 47: 242-7(July 1, 1967).

The yield of radiolytic hydrogen from solutions of perfluorocyclobutane in n-hexane was compared with that obtained from n-hexane solutions containing both perfluorocyclobutane and hexene-1 or benzene. A mechanism for radiolytic hydrogen formation, which assumes the existence of two precursors of molecular hydrogen is postulated. Thermal hydrogen atoms and molecular hydrogen are assumed to be formed from the decomposition of a short-lived excited-state C_6H_{14}', a process that cannot be affected by the presence of the solutes used. The recombination of the solvent molecular cation and an electron is assumed to result predominantly in the formation of "hot" hydrogen atoms. Perfluorocyclobutane decreased the hydrogen yield by scavenging electrons, while hexene-1 and benzene decreased the yield of hydrogen both by charge-transfer processes and by scavenging of hydrogen atoms formed from C_6H_{14}'. The yield of scavengeable electrons, positive charges, and thermal hydrogen atoms determined by kinetic analysis are: G (electrons) = 2.6, G(positive charges) = 2.1, G(thermal hydrogens) = 1.4. (auth)

36013 ESR EVIDENCE ON TRAPPED ELECTRONS AND "CO_2^-" IN γ-IRRADIATED 3-METHYLPENTANE. Shirom, M.; Claridge, R. F. C.; Willard, J. E. (Univ. of Wisconsin, Madison). Contract AT(11-1)-32. J. Chem. Phys., 47: 286-91(July 1, 1967).

The singlet ESR signal of γ-irradiated 3-methylpentane (3-MP) glass which is attributable to physically trapped electrons, and the singlet and doublet resulting from reaction of electrons with CO_2 in 3-MP glass, were examined. Immediately after production by a 10^{19}-eV g^{-1}, 5-min γ dose, the electron line decayed with an apparent half-life of less than 20 min. It was readily removed by illumination at 13 500 Å. ESR saturation was significant at 10^{-3} mW and prevented detection of the signal at powers above ~1 mW. The ESR g value and the radiation G value were estimated to be ~2.002 and 0.5 ± 0.2, respectively. When 3-MP or 2-methylpentene-1 (2-MP-1) containing CO_2 was γ irradiated at 77°K, a singlet (g = ~2.0007; linewidth = ~3.1 G) and a flanking doublet with a splitting of ~8 G were produced. The singlet, but not the doublet, showed saturation effects starting at ~0.05 mW. It may be removed by illumination of the sample at wavelengths of 4800 Å and below, producing new species, but was unaffected at 5500 Å and above. The initial ratio of the singlet to the doublet, the growth on standing at 77°K, and the rate of bleaching with ultraviolet light were sensitive to the amount of CO_2 present. The observed radiation G value in samples containing 1 mole % CO_2 and 99 mole % 3-MP, with a vapor–solid ratio of 8, was ~0.3. The spectra were

the same as those produced by photoionization of tetramethylparaphenylenediamine (TMPD) in 3-MP containing CO_2 at 77°K. (auth)

36014 THE PRODUCTION OF CARRIER-FREE ^{7}Be IN NUCLEAR REACTORS BY THE SECONDARY NUCLEAR REACTION ^{7}Li(p,n)^{7}Be. Aumann, D. C. (Technische Hochschule, Munich). Radiochim. Acta, 7: 64-71(June 1967). (In German).

Carrier-free ^{7}Be was produced by irradiating hydrogen-containing lithium compounds in the Munich Research Reactor by the secondary nuclear reaction ^{7}Li(p,n)^{7}Be using protons from neutron–hydrogen atom collisions. The dependence of the ^{7}Be production yield on the chemical composition of the irradiated compounds was investigated and compared with the predicted production yields. Radiochemical methods for the isolation and purification of the carrier-free radioberyllium from the irradiated lithium compounds was investigated. A simple separation scheme is proposed. (auth)

36015 ^{99m}TECHNETIUM GENERATOR USING SALINE SOLUTION. El Garhy, M.; El Bayoumy, S.; El Alfy, S. (Atomic Energy Establishment, Cairo). Radiochim. Acta, 7: 163-4(June 1967).

The direct production of ^{99m}Tc preparation by milking with a saline solution is described. Molybdenum trioxide was irradiated at a thermal neutron flux of 0.5 to 1.5×10^{13} n/cm^{2}sec. The irradiated target was dissolved in NaOH, a solution of Br_2 and concentrated HCl was added, the mixture warmed, and NaH_2PO_4 solution added. It was run into a column filled with alumina. The ^{99m}Tc generated was milked at 24 hr intervals using an 0.9% NaCl solution. Milking ^{99m}Tc took only 5 to 10 min and up to 90% of the total milked activity was found in the first 15 ml of the effluent. The efficiency of milking ranged between 75 and 85%. The radiochemical purity, obtained from gamma spectrum and decay curves measurements, was better than 99.99%. (D.H.M.)

36016 ELECTRON SPIN RESONANCE OF γ-IRRADIATED TETRAFLUOROETHYLENE–HEXAFLUOROPROPYLENE COPOLYMERS. Iwasaki, M.; Toriyama, K.; Sawaki, T.; Inoue, M. (Government Industrial Research Inst., Nagoya, Japan). J. Chem. Phys., 47: 554-9(July 15, 1967).

Radicals produced in tetrafluoroethylene–hexafluoropropylene copolymers γ-irradiated at room temperature in vacuo were studied by electron spin resonance. Besides the spectra assigned to the radicals $\ldots CF_2-\dot{C}F-CF_2\ldots$ and $\ldots CF_2-CF_2-O\cdot$, a poorly resolved eight-line spectrum was found and tentatively assigned to the tertiary carbon radical $\ldots CF_2-\dot{C}(CF_3)-CF_2\ldots$. Upon heating, this radical disappeared much faster than the others. This is probably because it is trapped in a region where the regular crystallization of the copolymer chains was perturbed by trifluoromethyl groups. The temperature and orientation dependence of the spectra were also examined and interpreted in terms of the proposed radical. (auth)

36017 ELECTRON SPIN RESONANCE OF ORIENTED RCHSR' SULFIDE RADICALS. Griffith, O. Hayes; Mallon, Michael H. (Univ. of Oregon, Eugene). J. Chem. Phys., 47: 837-40(July 15, 1967).

Single crystals of the di-n-hexyl sulfide–urea and diethyl sulfide–urea inclusion compounds were x irradiated at 77°K and the long-lived free radicals produced were investigated by electrons spin resonance. The free radicals observed in both crystals were of the type RĊHSR'. The value for the spin density on the carbon atom is 0.74 ± 0.07. The unpaired spin distribution is discussed in terms of simple molecular-orbital models. (auth)

36018 PHOTOINDUCED AND THERMAL RADICAL CONVERSIONS IN γ-IRRADIATED COPOLYMERS OF TETRAFLUOROETHYLENE AND HEXAFLUOROPROPYLENE AS STUDIED BY ELECTRON SPIN RESONANCE. Iwasaki, Machio; Toriyama, Kazumi (Government Industrial Research Inst., Nagoya, Japan). J. Chem. Phys., 47: 559-63(July 15, 1967).

It was found that a perfluorinated tertiary-carbon radical $\ldots CF_2-\dot{C}(CF_3)-CF_2\ldots$ formed in γ-irradiated copolymers of tetrafluoroethylene and hexafluoropropylene is converted into the radical $\ldots CF_2-CF(\dot{C}F)_2-CF_2\ldots$ by illumination of uv light at 77°K and the process is reversed by thermal annealing. This may be the first example of the photoinduced conversion of fluorocarbon radicals. The uv absorption spectra of perfluorinated tertiary-carbon radicals were also measured and a strong absorption was found at 2650 Å. The wavelength dependence of the radical conversion indicated that the photoisomerization of the tertiary-carbon radical was induced by the absorption of this light. The tentative assignment of the ESR spectra to the radical $\ldots CF_2-\dot{C}(CF_3)-CF_2\ldots$ previously was further confirmed by this experiment. In addition, it was found that γ irradiation at 77°K gives the radical $\ldots CF_2-CF(\dot{C}F_2)-CF_2\ldots$ as a forerunner radical of the tertiary-carbon radical found in room-temperature irradiation. (auth)

36019 γ RADIOLYSIS OF LIQUIDS AT HIGH PRESSURES. III. AQUEOUS SOLUTIONS OF SODIUM BICARBONATE. Hentz, Robert R.; Farhataziz; Milner, David J.; Burton, Milton (Univ. of Notre Dame, Ind.). J. Chem. Phys., 47: 374-7(July 15, 1967). (COO-38-525).

The γ radiolysis of deaerated aqueous solutions containing sodium bicarbonate and either glucose or isopropanol was studied at ~20°C in the applied pressure range 0 to 7 kbar. For 0.05M bicarbonate and 0.036M isopropanol, $G(H_2)$ increased from 0.89 to 2.43 as applied pressure increased from 0 to 6.9 kbar. A 100-fold change (0.005 to 0.5M) in bicarbonate concentration had little or no effect on the pressure dependence of $G(H_2)$. Because primary yields are invariant over the pressure range studied, the results are interpreted in terms of an effect of pressure on the competition between $e^-_{aq} + CO_2 \rightarrow CO_2^-$, (1) and $e^-_{aq} + HCO_3^- \rightarrow H + CO_3^{2-}$, (2) followed by $H + RH \rightarrow R + H_2$, (3). Such an interpretation gives a difference in activation volumes of reactions (1) and (2) as $\Delta V_1^{\ddagger} - \Delta V_2^{\ddagger} \approx 18.4$ ml mole^{-1} and a specific rate $k_1^0 \approx 6 \times 10^5 M^{-1} \cdot sec^{-1}$ at atmospheric pressure. Assumption that reaction (1) is diffusion controlled permits estimation of $\Delta V_1^{\ddagger} \approx 1.6$ ml mole^{-1}, from the pressure dependence of water viscosity. Thus, $\Delta V_2^{\ddagger} \approx -16.8$ ml mole^{-1}. The latter value, in turn, yields an estimate of $\bar{V}$ (e^-_{aq}) in the range −10.9 to −6.5 ml mole^{-1} relative to $\bar{V}(H^+) = 0$. Use of an absolute value of $\bar{V}_0(H^+) = -5.4$ ml mole^{-1} gives an absolute value of $\bar{V}_0(e^-_{aq})$ in the range −5.5 to −1.1 ml mole^{-1}. Approximate equality of the values for $\bar{V}_0$ of the electron and of the proton is consistent with their having a negligible intrinsic volume and approximately equal electrostriction volumes. (auth)

36020 ION–MOLECULE REACTIONS IN THE CONDENSED-PHASE RADIOLYSIS OF HYDROCARBON MIXTURES. II. CYCLOPENTANE AND CYCLOHEXANE. Ausloos, P.; Scala, A. A.; Lias, S. G. (National Bureau of Standards, Washington, D. C.). J. Amer. Chem. Soc., 89: 3677-83(July 19, 1967).

The radiolysis of c-C_5H_{10} and c-C_6H_{12}, as well as of equimolar c-C_5H_{10}–c-C_5D_{10} and c-C_6H_{12}–c-C_6D_{12} mixtures, was investigated in the presence of 0.5 to 5 mole % $(CD_2)_3$, C_2D_2, C_2D_4, or CD_3CDCD_2. Isotopic analysis of the products formed in the radiolysis of cycloalkane–$(CD_2)_3$ mixtures pointed to the occurrence of the following ion–molecule reactions: (a) $C_nH_{2n}^+ + (CD_2)_3 \rightarrow C_nH_{2n-2}^+ + CD_2HCD_2CD_2H$ and (b) $C_nH_{2n}^+ + (CD_2)_3 \rightarrow C_nH_{2n-1}^+ + CD_2HCD_2CD_2$. The formation of n-propyl radicals in reaction b was confirmed by the production of $CD_3CD_2CD_2H$ as a major species in the radiolysis of C_3D_{2n}–$(CD_2)_3$–H_2S mixtures. The ion–molecule character of the reactions was further confirmed by the facts that addition of a known parent ion interceptor such as H_2S reduces G(propane), while addition of an electron scavenger such as CCl_4 raises G(propane). When cyclopentane is the solvent, the H_2-transfer reaction (a) is of major importance. The most efficient H_2-acceptor molecule for the cyclopentane parent ion is C_2D_4, and the least efficient is C_2D_2. When c-C_5H_{10}–c-C_5D_{10} (1 : 1) mixtures are irradiated in the presence of deuterated H_2-acceptor molecules such as C_2D_4 or C_2D_2, the ratio of products of reaction a, $C_2D_4H_2/C_2D_6$ or $C_2D_2H_2/C_2D_4$, is greater than unity, indicating the occurrence of charge-transfer processes favoring the formation of c-$C_5H_{10}^+$: (c) c-$C_5D_{10}^+$ + c-$C_5H_{10} \rightarrow$ c-$C_5H_{10}^+$ + c-C_5D_{10}. A decrease in the mole per cent of the C_2D_4 or C_2D_2 from 6 to 2% raises $C_2D_4H_2/C_2D_6$ or $C_2D_2H_2/C_2D_4$ from 1.7 to 2.6, demonstrating that relatively high concentrations of H_2-acceptor molecules can interfere with the charge-transfer mechanism. When cyclohexane is the solvent, reaction b predominates over reaction a. A plot of the square root of the $(CD_2)_3$ concentration vs. G(propane) yields a straight line which goes through the origin, demonstrating the difficulty of obtaining chemical evidence for the presence of free ions. (auth)

36021 EFFECTS OF T^+ ION ENERGY ON THE YIELD OF LABELLED PRODUCTS FROM SOLID STATE BENZENE IRRADIATION. Kuklin, Yu. S.; Firsova, L. P. Vestn. Mosk. Univ., Ser. II Khim., No. 1, 120-3(Jan.-Feb. 1967). (In Russian).

The influence of radiolysis on the yield of labeled products was studied during solid benzene irradiation by tritium ions at 3 to 0.5 keV with the total number of incident T ions as 3.6×10^{15}, and benzene absorbed dose at 10^{23} to 10^{24} eV/g. The results of experiments carried out in a radiochromatograph are tabulated. (R.V.J.)

36022 TABLES OF NUCLEAR CHEMISTRY. Zeman, A. Chem. Listy, 60: 683-4(May 1966). (In Czech).

A table of isotopes with data on half-life, radiation energy, and other chemical and radiochemical properties is presented. Safety measures are described. Chemical properties of radioactive materials, ion exchanges, extraction by organic solvents in nuclear chemistry, products of radioactive decay, chemical and physical properties of products of decay, and some metals currently used in nuclear technology are discussed. The available literature and the best way of using published information are considered. (JPRS)

36023 DETERIORATION OF POLYETHYLENE FILM BY ION IRRADIATION. Sakai, T.; Sone, M.; Ito, T.; Toriyama, Y.

(Musashi Inst. of Tech., Japan). Elec. Eng. Jap. (Engl. Transl.), 86: 19-24(Apr. 1966).

Problems encountered in the use of various ion sources for studying etching of films were examined, and a technique was developed that involves ionizing reduced-pressure air (10^{-2} mm Hg) by a high-frequency discharge and then accelerating the resulting ions using a pulsed electric field. This method was developed to investigate the mechanism of corona-discharge deterioration of dielectric materials. The effects of ion irradiation on the dielectric properties of 3 polymers were studied. A nonelectrode high-frequency (11 Mcps) discharge in a vacuum of 30 μ Hg was used as the ion source, with the ions accelerated toward the specimen with a pulsed electric field of frequency of 1 kc, pulse width of 1 μsec, and pulse height of 5 kV. The surface damage could easily be observed, and both weight loss due to oxidation and a decrease of breakdown strength were noted. (TSS)

36024 PREPARATION AND APPLICATIONS OF RADIOACTIVE PHOSPHORUS ISOTOPES. Vasaros, Laszlo; Berei, Klara; Kiss, Istvan (Central Research Inst. for Chemistry, Budapest). Magy. Tud. Akad., Kem. Tud. Oszt., Kozlem., 26: 261-95(Nov. 1966). (In Hungarian).

Literature dealing with the preparation of ^{32}P preparates, preparation of ^{32}P, hot-atomic chemical reactions of ^{32}P, preparation of compounds labeled with ^{32}P, assaying and analysis of radioactive phosphorus preparates, and the applications of ^{32}P (medical, agricultural, industrial, physical, and chemical) was reviewed in considerable detail. (362 references). (JPRS)

36025 STUDIES OF THERMAL ANNEALING OF NEUTRON-IRRADIATED TRIS(DIPYRIDYL)COBALT (III) PERCHLORATE. REDISTRIBUTION OF ELECTRONS AMONG THE DONORS. Nath, Amar; Vaish, U. P. (Atomic Energy Establishment Trombay, India.). J. Chem. Phys., 46: 4660-5(June 15, 1967).

Thermally treated and untreated anhydrous samples of tris(dipyridyl) Co(III) perchlorate were hydrated at 30°C in air at a relative humidity of 93%. Some of them were chilled at −78°C while others were kept at 30°C for a prolonged period before chilling at −78°C. The chilled samples were neutron irradiated at −78°C. Thermally treated samples chilled immediately after hydration exhibited a much faster rate of thermal annealing as compared to the latter and to the trihydrate. These observations were interpreted on the basis of the variable-depth-electron-donors−isotopic-exchange model, which postulates an annealing rate proportional to the free-electron density. Evidence is presented for the creation of electron traps and electron−hole recombination centers during thermal treatment of the anhydrous form and for populating of the electron traps with electrons to form shallow donors during hydration through exo-electron emission. Hence, in the freshly hydrated samples kept at 30°C for prolonged periods before chilling and irradiation, a considerable amount of depopulation of the shallow donors takes place resulting in a slower rate of postrecoil thermal annealing. In contrast, the hydrated complex prepared by hydrating the untreated anhydrous sample exhibits a faster rate of annealing on storage at 30°C after hydration and prior to irradiation as compared to the samples chilled immediately after hydration. For the trihydrate it was shown that the electron traps constituted by the crystal imperfections are largely filled up with electrons during crystallization from aqueous solution. However, the process of filling up continues slowly during storage of $Co(dipy)_3(ClO_4)_3 \cdot 3H_2O$ at 30°C (or at higher temperatures). Consequently, the stored samples show a faster rate of annealing as compared to the freshly prepared ones. (auth)

36026 PAIRWISE TRAPPING OF DISSIMILAR RADICAL SPECIES AND RADICAL CONVERSION IN A SINGLE CRYSTAL OF MONOFLUOROACETAMIDE γ-IRRADIATED AT 77°K AS STUDIED BY ELECTRON SPIN RESONANCE. Iwasaki, Machio; Toriyama, Kazumi (Government Industrial Research Inst., Nagoya, Japan). J. Chem. Phys., 46: 4693-7(June 15, 1967).

Pairwise trapping of dissimilar radical species in irradiated crystals is reported. Besides the isolated radical of $\cdot CH_2CONH_2$, a radical pair between $\cdot CH_2CONH_2$ and $\cdot CHFCONH_2$ was found in a single crystal of CH_2FCONH_2, γ irradiated at 77°K. The paired radicals were formed with one specific orientation and separation, which were the same as with the molecules in the undamaged crystal. The observed principal values of the D tensor due to the magnetic dipole interaction of the two unpaired electrons gave a mean distance between the paired radicals of 7.03 Å. The alignment of the paired radicals was also determined by the principal directions of the D tensor. Both the separation and the alignment of the paired radicals thus obtained are in agreement with those calculated from the structure of the mother crystal. Furthermore, on warming the crystals the isolated radical $\cdot CH_2CONH_2$ was quantitatively converted into the radical $\cdot CHFCONH_2$, which is the same species as found in room-temperature irradiation. The pairwise trapping of dissimilar radicals and the radical conversion found must give important information in considering the primary process of the radiation-induced reaction. (auth)

36027 HYDROGEN FORMATION IN THE RADIOLYSES OF LIQUID BUTENE-1 AND trans-BUTENE-2. Hatano, Yoshihiko; Shida, Shoji (Tokyo Inst. of Tech.). J. Chem. Phys., 46: 4784-8(June 15, 1967).

The effect of temperature and various electron or positive-ion scavengers on hydrogen formation in the radiolyses of liquid butene-1 and trans-butene-2 was examined. The hydrogen formation was not appreciably affected by temperature and these additives, which indicates that thermal free radicals and ionic species may not play an important role in hydrogen formation from these olefins. The liquid-phase radiolyses of C_4H_8-1−C_4D_8-1 and trans-C_4D_8-2 mixtures were also investigated. The data indicate that hydrogen for the most part may be formed by bimolecular processes. The results led to the conclusion that the mechanism of the hydrogen formation may be interpreted in terms of the hydrogen-atom abstraction reaction of hot hydrogen atoms or the equivalent formed by the direct excitation, which may involve superexcitation. (auth)

36028 ISOTOPE EFFECT IN THE IONIZATION OF POLYATOMIC GASES BY ALPHA PARTICLES. Jesse, William P. (St. Procopius Coll., Lisle, Ill.). J. Chem. Phys., 46: 4981-3(June 15, 1967).

The isotope effect in the ionization of polyatomic gases was investigated where the ionizing agent was a collimated beam of alpha particles directed parallel to the axis of a cylindrical brass chamber of length 22 cm and internal dia 10 cm. The increment of ionization produced by each individual alpha particle fed into a vibrating-reed electrometer caused a jump of several centimeters on the chart of a Brown strip chart recorder. The length of these jumps was recorded and averaged and a comparison made of such averages obtained in alternate runs for a deuterated and an undeuterated gas under similar conditions of pressure and temperature. (auth)

36029 GAS-PHASE PHOTOLYSIS AND RADIOLYSIS OF METHANE. FORMATION OF HYDROGEN AND ETHYLENE. Gorden, R. Jr.; Ausloos, P. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 46: 4823-34(June 15, 1967).

The photolysis of CH_4 and of CH_4-CD_4 mixtures was investigated at 1236 Å (10.0 eV) and at 1048 to 67 Å (11.6 to 11.8 eV). The excited methane molecule dissociates to form H_2, H, CH_3, CH_2, CH, and probably also C. The CH and CH_2 radicals insert into methane to form internally excited $C_2H_6^*$ and $C_2H_5^*$ species, respectively. Below one atmosphere, all C_2H_5 radicals decompose to form C_2H_4, while the ethane molecules are partially stabilized. The relative quantum yield of CH increases about threefold when the wavelength is reduced from 1236 Å to 1048 to 67 Å. On the basis of an isotopic analysis of the hydrogen produced in the photolysis of CD_4-H_2S mixtures, it was concluded that at 1236 Å, D atoms constitute at least 65% of the "molecular" deuterium yield. In radiolysis, ethylene is largely, although not exclusively, formed by the insertion of CH into methane. It is demonstrated that addition of small concentrations of an unsaturated hydrocarbon to methane affects the ion-molecule reaction mechanism and, therefore, does not lead to a dependable value of the "initial" ethylene yield as suggested in earlier studies. On application of an electrical field, the production of CH and CH_2 is augmented in the saturation current region. The importance of the latter two radicals in the direct and rare gas-sensitized radiolysis is examined briefly. The formation of hydrogen in the radiolysis is discussed on the basis of new information derived from CD_4-H_2S experiments. The production of hydrogen in the radiolysis of Xe−CH_4-CD_4−NO mixtures was also re-examined in view of a recent study in which it was asserted that all of the hydrogen in such a mixture is due to the unimolecular decomposition process, $CH_4^* \rightarrow CH_2 + H_2$. Our data disagree with this view and actually demonstrate that CH and CH_2 play a minor role in the xenon-sensitized radiolysis of methane. (auth)

36030 PREPARATION OF FROZEN SAMPLES FOR γ IRRADIATION, ESR INVESTIGATION, AND SIMILAR EXPERIMENTS AT LOW TEMPERATURES. Zagorski, Zbigniew Pawel (Inst. of Nuclear Research, Warsaw). Rocz. Chem., 41: 991-3(1967).

A technique of frozen sample preparation is described consisting of casting of the sample of desired shape in a mold made from solidified mercury. The technique can have no universal application, but is useful for aqueous solutions that show sufficient mechanical strength after solidification. Excellent results were obtained with alkaline solutions. (D.H.M.)

36031 RADIOLYSIS OF SOLID AMMONIUM DICHROMATE AND ITS NEUTRAL SOLUTIONS. Nawojska, Jadwiga (Inst. of Low Temperatures and Structural Research, Wroclaw). Rocz. Chem., 41: 889-95(1967).

Solid ammonium dichromate and its neutral solutions were ir-

radiated with γ rays. The resulting brown precipitate was analyzed and subjected to magnetic and spectroscopic (infrared) measurements, which enabled its formula to be established as $[Cr(OH)_2]_2CrO_4$. A mechanism of its formation during the radiolysis of neutral solution and solid ammonium dichromate is proposed. (auth)

36032 MODIFICATION OF THE RADIOLYTIC OXIDATION OF RIBONUCLEASE INDUCED BY BOUND COPPER. Levitzki, Alexander; Anbar, Michael (Soreq Nuclear Research Center, Yavneh, Israel. Weizmann Inst. of Science, Rehovoth, Israel). J. Amer. Chem. Soc., 89: 4185-9(Aug. 2, 1967).

The specific effect of cupric ions on the radiolytic oxidative inactivation of enolase and ribonuclease was investigated. It was shown that cupric ions bound to the enzymes enhance the radiolytic inactivation induced by OH radicals. The destruction of the amino acid residues was followed in parallel to enzymatic inactivation in the absence and in the presence of Cu^{2+}. Complexing of Cu^{2+} by RNAase does not alter the total yield of radiolytic destruction of amino acid residues, but induces a significant change in the radiolytic yield of individual amino acid residues sensitive to oxidation. A significant increase in the yield of radiolyzed histidyl residues on RNAase in the presence of Cu(II) was observed, accompanied by a corresponding decrease in damaged S–S bonds. A quantitative evaluation of the effect of OH radicals on RNAase in the presence and absence of copper suggests an intramolecular charge transfer in the protein molecule following its reaction with OH radicals. The radiobiological implications of the copper-induced "sensitization" of vital sites in a bipolymer are discussed. (auth)

36033 COMPARISON OF SOLVATED ELECTRON RATES IN WATER AND IN ICE. Kevan, Larry (Univ. of Kansas, Lawrence). J. Amer. Chem. Soc., 89: 4238-9(Aug. 2, 1967).

Relative reaction rates of mobile electrons produced by γ irradiation of ice at 77°K were measured. These rates quantitatively parallel those in water at 300°K and support the conclusion that entropic effects are responsible for the rate differences. (M.C.G.)

36034 ISOTHERMAL ANNEALING OF REACTOR-IRRADIATED CRYSTALLINE POTASSIUM CHROMATE. Dimotakis, Paul N.; Stamouli, Maria I. (Democritus Nuclear Research Center, Athens). Z. Phys. Chem. (Frankfurt), 55: 197-201(July 1967).

The thermal annealing of nuclear recoil interstitial atoms of reactor-irradiated crystalline potassium chromate was investigated in detail. The isothermal annealing was performed at various temperatures and for periods lasting up to 24 hr. The isothermal curves drawn by simply joining the points with smooth curves showed the presence of many maxima and minima proving a concept in thermal annealing previously presented. It all seems to be due to consecutive defect transformations, which are followed by the process of recombination of nuclear recoil interstitials with their parent vacancies. (auth)

36035 STRUCTURAL DEPENDENCE OF THE LUMINESCENCE DAMAGE TO ORGANIC MOLECULAR CRYSTALS BY GAMMA RADIATION. Stolz, W.; Schmitt, W. (Technische Univ., Dresden). Ann. Phys., 19: 364-9(1967). (In German).

The damage to organic molecular crystals capable of luminescence by ^{60}Co γ rays was investigated in relation to the chemical structure of the compounds from the group: polyphenyls, diphenyl, acenes, and related materials. The radioinduced disintegration of the emission peaks of photoluminescence occurred according to the hyperbolic disintegration law $I/I_0 = (1 + A \cdot D^n)^{-1}$. The radiation resistance of a compound originated in a close relation between the number of π-electrons and the resonance energy. With increasing resonance energy an increased radiation resistance was observed. (tr-auth)

36036 RADIATION-INDUCED CHANGES IN THE INDEX OF REFRACTION, DENSITY, AND DIELECTRIC CONSTANT OF POLY(METHYL METHACRYLATE). Gardner, Donald G.; Toosi, Mohammad T. A. (Illinois Inst. of Tech., Chicago. Univ. of California, Livermore). Contract W-7405-eng-48. J. Appl. Polymer Sci., 11: 1065-78(July 1967). (UCRL–14649).

Samples of commercially prepared poly(methylmethacrylate) (Lucite) were irradiated with 13-MeV electrons in the dose range 0 to 11 MRAD, and the induced changes in the index of refraction density, and dielectric constant were observed. An attempt was made to interrelate the observed changes theoretically. (auth)

36037 RADIATION-INDUCED SOLID-STATE POLYMERIZATION IN BINARY SYSTEMS. V. POLYMERIZATION IN BINARY SYSTEMS CONTAINING LONG CHAIN COMPOUNDS. Kaetsu, Isao; Hayashi, Koichiro; Okamura, Seizo (Kyoto Univ.). J. Appl. Polymer Sci., 11: 1101-16(July 1967).

Radioinduced solid-state polymerization in binary systems containing long-chain compounds was investigated. Butyl stearate–methyl methacrylate and stearyl alcohol–methyl methacrylate systems were studied in detail. In these systems in-source polymerization did not occur but a remarkable post-polymerization took place on warming after irradiation at low temperature. The limiting conversion characteristics of this post-polymerization depended greatly on the nature and the concentration of the long-chain compounds. The post-polymerization was observed to be more marked in the butyl stearate–methyl methacrylate system than in the stearyl alcohol–methyl methacrylate system, and it increased with increasing concentration of the long-chain component. An optimum warming rate and warming temperature existed for the maximum saturated conversion. Irradiation in air caused some decrease of conversion compared to irradiation in vacuo. The possible mechanism is that monomer diffuses into the crystals of the long-chain compound after melting at the eutectic temperature. The polymerization may be initiated by trapped radicals of the long-chain compound and carried out in the crystal of the long-chain compound with a smaller possibility of termination. In binary systems containing long-chain compounds, lowering of the melting point was slight, and the eutectic composition existed at the richer composition of monomer, so almost all the long-chain substance remained as excess crystals, which were suitable for holding trapped radicals. The crystal lattices of long-chain compounds may be softer than those of compounds of small molecular size. This fact is favorable for monomer diffusion. This explains why such a post-polymerization takes place only in systems containing long-chain molecules. (auth)

36038 RADIATION-INDUCED SOLID-STATE POLYMERIZATION OF VINYL COMPOUNDS IN BINARY SYSTEMS. Nishii, Masanobu; Tsukamoto; Hiroshi; Hayashi, Koichiro; Okamura, Seizo (Japanese Association for Radiation Research on Polymers, Osaka). J. Appl. Polymer Sci., 11: 1117-28(July 1967).

The radioinduced solid-state polymerization in the binary systems such as acrylamide–methacrylamide and acrylamide–acenaphthylene was studied. The former system formed a solid solution, and the latter one formed a eutectic mixture. In the solid solution, the polymerization proceeds homogeneously and copolymer is formed, while in the eutectic mixture, it proceeds heterogeneously, forming only homopolymer. The post-polymerization of the same binary systems was also studied. Linearity between the conversion and the logarithm of the post-polymerization time was found for the various monomer compositions at various temperatures. This relationship satisfied the kinetic equation presented by Morawetz et al., for the post-polymerization of acrylamide. The kinetics of the binary systems might be considered similarly to the single system, considering that the crystalline state of the system is changed by the monomer compositions. (auth)

36039 EFFECT OF AROMATIC GROUPS ON LOCALIZATION OF HIGH ENERGY IN CELLULOSE. Arthur, Jett C. Jr.; Stanonis, David J.; Mares, Trinidad; Hinojosa, Oscar (Dept. of Agriculture, New Orleans). J. Appl. Polymer Sci., 11: 1129-38(July 1967).

When γ radiation from ^{60}Co interacted with fibrous cotton cellulose, localization of at least part of the high energy resulted in cellulosic chain cleavage and loss in breaking strength of the irradiated fibers. The substitution of aromatic groups on the cotton cellulose molecule affected this localization of energy and decreased the radiation degradation of the fiber. The nature of the linkage of the aromatic group to the cellulose molecule was not as important as the radiation stability of the linkage. For example, if localization of energy occurred, which cleaved the aromatic group from the cellulose molecule, the radioprotection of the cellulosic molecular chain by the aromatic group was not effective. If the aromatic group was so modified that the effective number of π-electrons was decreased, the radioprotection of the cellulosic chain was also decreased. The radioprotection of the cellulosic molecular chain by benzhydryl, trityl, benzoyl, and cinnamoyl groups was effective over distances equivalent to several cellobiose units. The radioprotection of the cellulosic chain by naphthoyl groups was significant but not as effective as the listed groups. Due to the sharing of π-electrons in the naphthoyl group, the effective number of π-electrons was reduced, and consequently the radioprotective effect of the group was also reduced. Benzyl groups were cleaved from the cellulose molecule on irradiation and offered no radioprotection to the cellulosic chain, at least at the high radiation dosages used. The ESR spectra of the irradiated celluloses, both substituted and unsubstituted, were similar. This indicated that the presence of aromatic groups did not change the nature of the long-lived free radicals induced in cellulose on irradiation. It was suggested that selective energy absorption by the aromatic group from the spur of high-energy

electrons produced on interaction of γ-radiation with the cellulose molecule could account for the radioprotection of the cellulosic molecular chain. (auth)

36040 ESR STUDY OF POST-IRRADIATION REACTIONS OF CELLULOSE AND ACRYLONITRILE. Baugh, Peter J.; Hinojosa, Oscar; Arthur, Jett C. Jr. (Dept. of Agriculture, New Orleans). J. Appl. Polymer Sci., 11: 1139-53(July 1967).

An ESR study of the free-radical mechanisms of the post-irradiation reactions of cotton cellulose with acrylonitrile is reported. The effects of atmosphere, moisture content, and solutions of acrylonitrile on the yield and stability of free-radical sites in irradiated cellulose were determined. On interaction of γ radiation from a ^{60}Co source with cotton cellulose, long-lived free-radical sites were found within the molecular lattice. Short-lived free-radical sites were apparently also formed on chain cleavage, gave strong singlet spectra, and were readily accessible to interaction with water. Other free-radical sites were formed within regions of the cellulosic fiber, which were inaccessible to moisture or aqueous solutions even after contact times as long as three days. It was suggested that long-lived free-radical sites in cellulose I (containing regain moisture) resulted from dehydrogenation at C_5, and in cellulose II (containing regain moisture) resulted from dehydrogenation at C_5 and dehydrogenation of the OH group or dehydroxylation at C_6. When irradiated cellulose was contacted with a solution of acrylonitrile (15%) in 75% aqueous zinc chloride, the initial rate of decrease in spin concentration was higher than the rate of decrease as the time of contact increased. The ESR spectrum of the reacted cellulose, observed at −100°C., as compared with the spectrum for the irradiated cellulose, decreased in signal strength with increase in time of contact and changed from a three-line spectrum to an ill-defined spectrum. The free radical observed was probably due to unreacted sites in the cellulose. The extent of the graft copolymerization reaction was directly related to the initial spin concentration in the irradiated cellulose. (auth)

36041 γ-RAY INDUCED TELOMERIZATION REACTIONS BETWEEN ALLYLIC COMPOUNDS AND CARBON TETRACHLORIDE. IV. REACTIONS OF ACETATES OF METHYL-SUBSTITUTED ALLYLIC ALCOHOLS. Okubo, Masao (Government Industrial Research Inst., Nagoya, Japan). Bull. Chem. Soc. Jap., 40: 1672-7(July 1967).

The γ-induced telomerization of allyl, α-methallyl, α,α-dimethylallyl, and β-methallyl acetates with carbon tetrachloride was carried out in order to compare the effects of methyl substituents. In the first 3 the effect of successive methyl substitution on the allylic α-position showed exactly the same regularity as to the effects on the velocities of C=C consumption, the telomer production ratios, and their change with the initial concentration of esters. The β-methyl substituent retarded the velocity of the C=C consumption to the utmost extent, it retarded telomer production ratio only a little, and it depressed the effect of ester concentration. Together with these observations, the amounts of hydrogen chloride generated during irradiation are discussed in relation to the degradative chain transfer mechanism. (auth)

36042 RETENTION OF OPTICAL CONFIGURATION DURING ENERGETIC CHLORINE ATOM EXCHANGE IN GASEOUS ALKYL HALIDES. Wai, Chien M.; Rowland, F. S. (Univ. of California, Irvine). Contract AT(11-1)-34. J. Phys. Chem., 71: 2752-3(July 1967).

The stereochemistry of the substitution at asymmetric carbon atoms of energetic halogen atoms, activated by nuclear recoil, was studied in the reaction, $^{38*}Cl + RCl \rightarrow R^{38}Cl + Cl$, in gas-phase experiments. The exchange proceeded with almost complete retention of optical configuration with either DL- or meso-2,3-dichlorobutane. Relative yields of DL- and meso-^{38}Cl-2,3-dichlorobutane from reactions of $(n,\gamma)^{38}Cl$ with gaseous 2,3-dichlorobutane are tabulated. Experiments were also carried out using the nuclear reaction, $^{40}Ar(\gamma,p)^{39}Cl$, with similar results. (J.G.B.)

36043 A PULSE RADIOLYSIS STUDY OF SOLUTIONS OF α-CHLOROTOLUENE IN CYCLOHEXANE. Hagemann, Robert J.; Schwarz, Harold A. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. J. Phys. Chem., 71: 2694-9(July 1967). (BNL-11032).

The yield of the benzyl radical was measured as a function of α-chlorotoluene concentration in liquid cyclohexane. The effects of nitrous oxide on the formation of the benzyl radical and the effects of α-chlorotoluene on the hydrogen yield from cyclohexane solutions were studied. It appears that in liquid as in glasses the main process of formation of the benzyl radical is via electron dissociative capture; the ion pairs measured as benzyl radical are only two-thirds of the yield measured as nitrogen from nitrous oxide. The α-chlorotoluene also reacted with hydrogen atoms. The hydrogen atom yield for cyclohexane was found to be between 1 and 1.5. The extinction coefficient of the benzyl radical was determined to be 12,000 M^{-1} cm^{-1}. (auth)

36044 COMPETITION BETWEEN SCAVENGERS IN THE VAPOR-PHASE RADIOLYSIS OF HYDROCARBONS. Holtslander, W. J.; Freeman, G. R. (Univ. of Alberta, Edmonton). J. Phys. Chem., 71: 2562-4(July 1967).

When two electron scavengers S_1 and S_2 are present in a radiolysis system, the reaction $S_1^- + S_2 \rightarrow S_1 + S_2^-$ can occur if S_2 has a greater electron affinity than does S_1 and if S_1^- has a long enough lifetime to enable it to encounter an S_2 and react with it. In 380 torr of methylcyclohexane vapor at 110°, the half-lives of N_2O^- and SF_6^-, with respect to decomposition, are $\geq 10^{-4}$ and $\geq 10^{-7}$ sec, respectively. The electron affinities of the three electron scavengers used apparently decrease in the order DI > SF_6 > N_2O. (auth)

36045 ARGON-SENSITIZED RADIOLYSIS OF ETHYLENE IN THE LIQUID PHASE. Klassen, Norman V. (Mellon Inst., Pittsburgh). Contract AT(30-1)-2310. J. Phys. Chem., 71: 2409-15(July 1967). (RRL-2310-185).

The ^{60}Co γ radiolysis of ethylene and ethylene−argon solutions was studied in the liquid phase at −161°. Ethylene was efficiently decomposed even in solutions containing as low as 0.0005 mole fraction of ethylene. The production of acetylene, ethane, and n-butane was enhanced by dilution with argon, while that of the hexenes and butenes was reduced. Below 1% ethylene the G values of all observed products were essentially independent of ethylene concentration. The results are discussed in terms of energy transfer to ethylene from ionic and excited states of argon. (auth)

36046 COMPETITION STUDIES OF THE HYDROXYL RADICAL REACTIONS IN SOME γ-RAY IRRADIATED AQUEOUS SOLUTIONS AT DIFFERENT pH VALUES. Draganic, Z. D.; Kosanic, M. M.; Nenadovic, M. T. (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia). J. Phys. Chem., 71: 2390-5(July 1967).

Competition studies of OH radical reactions were performed on the following oxygenated aqueous systems: $C_2H_5OH + H_2C_2O_4$, $CH_3OH + H_2C_2O_4$, $C_2H_5OH + KBr$, and $CH_3OH + KBr$. The corresponding rate constant ratios were measured at pH 6 to 7, 2.7, and 1.3. The cross-check confirmed the correctness of the reaction schemes used and the relative rate constants measured. From these data the ratio $k_{OH+ethanol}/k_{OH+methanol}$ was derived. Assuming $k_{OH+ethanol} = 1.06 \times 10^9$ M^{-1} sec^{-1}, the following absolute rate constants were calculated for OH radical reactions with different forms of oxalic acid: 0.6×10^7, 3.5×10^7, and $<10^7$ M^{-1} sec^{-1} for $C_2O_4^{2-}$, $HC_2O_4^-$, and $H_2C_2O_4$ forms, respectively. The pH effect on the rate constant of the OH radical reaction with bromide ions was also confirmed. The following values were derived for k_{OH+Br^-}: 5.8×10^9, 4.0×10^9, and 0.6×10^9 M^{-1} sec^{-1} at pH 1.3, 2.7, and ~6, respectively. The intercepts of competition diagrams gave primary hydroxyl radical yields in good agreement with the value previously obtained for the aqueous oxalic acid−oxygen system at the pH values studied. (auth)

36047 ESR STUDIES ON THE STABILITY OF TRAPPED ELECTRONS IN PHOTOIONIZED AND GAMMA-IRRADIATED ORGANIC GLASSES. Lin, J.; Tsuji, K.; Williams, F. (Univ. of Tennessee, Knoxville). Contract AT(40-1)-2968. Chem. Phys. Lett., 1: 66-8(Mar.-Apr. 1967). (ORO-2968-24).

Trapped electrons were detected by electron spin resonance following photoionization and gamma irradiation experiments with several organic glasses at 77°K. The results showed that for each glassy material, the trapped electron had a characteristic thermal stability which was unaffected by the method of generation. It was concluded that in these systems, the mobility of the trapped electron was the decisive factor in controlling the rate of thermal decay. The electron mobility in 3-methylpentane appeared to be strongly influenced by the presence of polar molecules (amines) in the environment. (auth)

36048 CIRCULATING RATE EFFECT OF RADIATION-INDUCED CONVERSION OF ORGANIC COOLANTS AT ELEVATED TEMPERATURES. Florentsev, M. M.; Brodskii, A. M.; Aleksenko, Yu. N.; Zvonov, N. V.; Batalov, A. A. At. Energ. (USSR), 22: 378-84(May 1967). (In Russian).

The decomposition of some organic coolants in the x radiation field of nuclear reactors at temperatures from 250 to 520°C and with residence times of the order of a tenth of a second was studied. The dependence of the rate of the radiation-thermal decomposition on the circulation rate was shown. An explanation is given of the results obtained, based on the assumption that the indicated times compared with the decomposition time of aromatic radicals obtained under the assumed conditions. The effect existed during evaluation of the possibility of increasing the stability with respect to the destruction of organic materials in a radiation field, in particular during use of organic coolant−moderators in reactors. (tr-auth)

36049 DUAL-CYCLE CHEMONUCLEAR NITROGEN FIXATION PROCESS. Beller, M.; Epel, L. G.; Steinberg, M. (Brookhaven National Lab., Upton, N. Y.). Chem. Eng. Progr., 63: No. 4, 51-5(Apr. 1967).

An economic and design study is presented for the production of fixed nitrogen, which utilizes both direct fission fragment energy and indirect thermal energy from a nuclear reactor. The results indicate that the method can prove competitive with conventional nitrogen fixation techniques, provided that G values of at least 6.0 can be achieved and that plant capacities are on the order of 3,000 ton/day fixed nitrogen. (auth)

36050 ON THE FORMATION OF AMINO ACIDS BY GAMMA-RAY-INDUCED CARBOXYLATION OF AMINES IN AQUEOUS SOLUTION. Getoff, N.; Schenck, G. O. (Max-Planck-Institut fuer Kohlenforschung, Ger.). Radiat. Res., 31: 486-505(July 1967).

The γ-induced formation of amino acids was studied by means of carboxylation of amines in aqueous solutions with ethylamine, n-propylamine, isoamylamine, and pyrrolidine as model substrates. The carboxylation process was investigated as a function of radiation dose, pH value of the solution, concentration of amines, and carbon dioxide. As a rule, by the carboxylation of the individual amines several amino acids were formed. This suggests that, under the influence of radiation, various free amino radicals are produced from the corresponding amine. In dilute solutions of amine ($<10^{-1}$ mole/liter) the primary products of water radiolysis (OH, H, e^-_{aq}) play a dominant role. In this case an H atom is abstracted preferentially from the α-C atom of the amine. Simultaneously with these processes CO_2 is reduced by e^-_{aq} and H atoms to COO^- radical ions and COOH radicals. The free amino radicals are subsequently carboxylated, yielding the corresponding α-amino acids with G_i up to 1.25. Dehydrogenation at other positions in the amine molecule occurs only to a minor extent, generally, these secondary reactions resulting in alkylation and, in ethylamine carboxylation, even cyclization. This effect will become more pronounced with high doses as the carbon dioxide is used up in the reaction. At higher amine concentrations (above 10^{-1} mole/liter) direct radiation effects become more and more important. Free amino radicals and radical ions result from the splitting of amine molecules into different fragments. Under the experimental conditions not all amino radicals are carboxylated; therefore higher amines are obtained also. In the study of the carboxylation of amines as a function of radiation dose the yield of all amino acids tends to reach a limiting value; the amino acids formed will react with the primary products of water radiolysis above a certain concentration. The yield of amino acids increases with increasing carbon dioxide concentration in the solution. The amino acid yield from the carboxylation of different amines is strongly pH-dependent. In preliminary experiments amino acids were formed by amination of acetic and propionic acid, their yield being comparable to the yield obtained from the carboxylation of the corresponding amines. (auth)

36051 DECOMPOSITION OF CYCLOHEXYL AMINES THROUGH IRRADIATION. Tsujino, Takeshi; Ishihara, Takehiko; Kikuchi, Teruo (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 4: 317-18(June 1967).

The decomposition of cyclohexyldidodecylamine, cyclohexyldodecylamine, and trioctylamine by ^{60}Co γ radiation was investigated through observation of variations seen in amine value, with a view to elucidating the changes in extraction characteristics brought about by irradiation. All the amine values markedly decreased with irradiation to 10^8 R. G-values are 0.88, 1.09, and 3.85 for cyclohexyldidodecylamine, trioctylamine, and cyclohexyldodecylamine, respectively. (M.C.G.)

36052 RADIOLYSIS OF SUCCINIC ACID IN WATER. Tanaka, Fred Shigeru. Corvallis, Ore., Oregon State Univ., 1966. 71p.

Thesis.

The radiolysis of succinic acid in aqueous solutions induced by γ irradiation from ^{60}Co was studied with respect to the identification and estimation of degradation products. Detailed information on the radiolysis of succinic acid is important in determining what effect two carboxyl groups in the same molecule would have on the reaction mechanisms and products relative to the degradation of the hydrocarbon chain resulting from gamma irradiation. ^{14}C-labeled succinic acid was employed to facilitate product identification and estimation. In addition, specifically labeled succinic acid-^{14}C and malic acid-^{14}C were utilized for elucidation of reaction mechanisms. The irradiation experiments were performed in both oxygenated and oxygen-free systems. The principal means of identification of the radiolytic products were by paper chromatography and autoradiography, utilizing the technique of co-chromatography. The estimation of each radiolytic product was determined by radiochemical assay using liquid scintillation counting techniques. The oxidation reactions in both oxygenated and oxygen-free systems may possibly follow the same reaction mechanisms, since the degradation products resulting from these reactions are the same in the oxygenated and oxygen-free systems, although the yields are greater in the oxygenated system. The oxidation products identified from the radiolysis of succinic acid were malic, malonic, oxaloacetic, pyruvic, oxalic, mesoxalic, glyoxylic, propionic, acetic, and formic acids, glyoxal, and carbon dioxide. The products of molecular weight greater than succinic acid produced exclusively from radiolysis in the oxygen-free system were 1,2,3,4-butane-tetracarboxylic, 1,2,4-butane-tricarboxylic, tricarballylic, glutaric, and adipic acids. The radiochemical yields of the radiolytic oxidation products from specifically labeled succinic acid-^{14}C were determined to be greater in the oxygenated system than in the oxygen-free system. This fact indicates that oxygen plays an important role in the radiolytic degradation of succinic acid. The graphical presentation of the degradation of succinic acid and the formation of malonic and malic acids with increasing cumulative dose follow the same course in both oxygenated and oxygen-free systems. However, the radiolytic degradation of succinic acid and the formation of malonic and malic acids were greater in the oxygenated system. The formation of malonic acid from radiolysis of succinic acid aroused considerable interest, since this acid was produced in unusually high yield. Therefore, studies were carried out to elucidate the mechanism for malonic acid formation. The results for radiolysis of ^{14}C specifically labeled succinic acid indicated that malic acid probably was an intermediate in the formation of malonic acid. In order to verify this result, specifically labeled malic acid-^{14}C was used in similar irradiation experiments. The results of this experiment indicated that malonic acid formation resulted from C-1 decarboxylation of malic acid followed by oxidation of the intermediate. Several reaction mechanisms were suggested as possible mechanisms for the formation of malonic acid. The most likely mechanism involved ·OH addition across the double bond of the enol form of oxaloacetic acid, in which decarboxylation of the adduct accompanied by oxidation resulted in the formation of malonic acid. (Disser. Abstr.)

36053 NUCLEAR CHEMISTRY. Harvey, Bernard G. Foundations of Modern Chemistry Series. Englewood Cliffs, N. J., Prentice-Hall, Inc., 1965. 127p. $4.95, Cloth; $1.95, Paper.

Introductory and advanced concepts of nuclear chemistry are discussed with detailed explanations of the atomic nucleus; forces within nuclei; theories of nuclear structure; radioactive decay; nuclear reactions and fissions; radiation, matter, and counters; particle acceleration; and reactors. There is a subject index as well as suggestions for related reading. (P.C.S.)

36054 GAMMA-RAY INITIATED POLYMERIZATION OF VINYL MONOMERS. Trewiler, Carl Edward. Akron, Ohio, Univ. of Akron, 1966. 143p.

Thesis.

An investigation was made of the polymerization or attempted polymerization of the following monomers by γ radiation (7.1 to 7.6×10^5 RAD/hr) at low temperature (-78°C): acrylonitrile, 3-butenenitrile, ethylene, fluoroethylenes, fumaronitrile, isobutene, para-nitrostyrene, perfluorobutene-2, perfluoropropylene, tetracyanoethylene, vinyl triethoxysilane, and vinyl chloride. Acrylonitrile showed erratic results. 3-Butenenitrile, ethylene, perfluorobutene-2, perfluoropropylene, tetracyanoethylene, and vinyl triethoxysilane were found to have extremely slow polymerization rates. Polymerization of fumaronitrile and para-nitrostyrene could not be detected. The polymerization of the fluoroethylenes, vinyl fluoride (VF), vinylidene fluoride (VF_2) and trifluoroethylene (VF_3) is best explained by a reaction propagating through a cationic intermediate. Attempts to copolymerize these fluorinated monomers with such co-monomers as isobutene and vinyl chloride led to the exclusive homopolymerization of the isobutene and vinyl chloride. (Disser. Abstr.)

36055 SCAVENGER KINETICS IN THE RADIOLYSIS OF CYCLOHEXANE–METHYL IODIDE SOLUTIONS. Mani, Inder. Gainesville, Fla., Univ. of Florida, 1966. 102p.

Thesis.

Competitive reactions of HI and I_2 with free radicals in γ-irradiated liquid cyclohexane and cyclohexane-methyl iodide solutions were studied. The experimental data consist of graphs of iodine concentration vs dose for experiments in which HI, I_2, or both are added to pure, degassed cyclohexane and for experiments in which HI or I_2 is added to degassed cyclohexane–methyl iodide solutions of differing composition before radiolysis. It was shown from a simple mechanism that total iodine yields, total free radical yields, and yields for HI produced and consumed can be calculated from a knowledge of the limiting rates of iodine production (or consumption) at zero dose with added I_2, HI, and no additives. Differential

rate expressions for HI and I_2 concentrations were readily obtained but they cannot be integrated analytically. However, it is possible to integrate them numerically using the second-order Runge-Kutta method on an IBM 7090 computer. The computer program allows evaluation of the role of various parameters in determining the shape of experimental iodine concentration vs dose graphs. For pure cyclohexane and for cyclohexane–methyl iodide solutions having 99.9% cyclohexane, it was found that hydrogen atoms also take part in scavenging reactions together with free radicals. The effective hydrogen atom yield used in the calculations depends on the initial scavenger concentration. Hydrogen atom yields for different scavenger concentrations are reported. The ratio of the rate constants k_{HI}/k_{I_2} was also used as an adjustable parameter and the values of these ratios for the various cyclohexane–methyl iodide solutions, having 20 to 100% cyclohexane, were found to be in the range of 0.55 to 0.98. The calculations also provided the yield of thermal alkyl radicals that escape the spurs, and the yields of I_2 and HI from spurs. (Disser. Abstr.)

36056 RADIATION RESISTANT FLUIDS. Hollinghurst, Ralph (to Mobil Oil Co. Ltd.). British Patent 1,075,571. July 12, 1967. Filed Nov. 30, 1962.

A radiation-resistant fluid containing at least one partially hydrogenated terphenyl together with one of the following other components is proposed; a hydrocarbon mineral oil, 1 to 20 wt % unhydrogenated polyphenyl, 1 to 30 wt % polystyrene or polyalkylstyrene, or an alkyl or aryl selenide or aryl disulfide. The degree of hydrogenation of the terphenyl is such that the total polyphenyl components present is at least 30 % of the theoretical amount for complete hydrogenation. (B.L.M.)

Radiochemistry

Refer also to abstracts 35889 and 36022.

36057 (EUR-3488.e) CALCULATION OF THE FRACTIONAL RELEASE OF GASES FROM A SPHERE AFTER RECOIL BOMBARDMENTS. Di Cola, G.; Matzke, Hj (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). May 16, 1967. 15p. Dep.

Gas release from a recoil-bombarded sphere of inert material on annealing at a given temperature was calculated. Two sources of recoil gas atoms are considered: one of infinite width, the other infinitesimally thin compared to the recoil range in the source. Some additional results are presented for the release from a recoil-bombarded cylinder. Derived equations are given and values of the fractional release, F, are tabulated and reproduced in figures using results obtained from a standard 7090 electronic computer. (auth)

36058 (JINR-D7-3444) SYNTHESIS AND STUDY OF THE PROPERTIES OF ELEMENT 102. Flerov, G. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1967. 36p. Dep.

Works devoted to the synthesis of element 102 are reviewed. The alpha decay, spontaneous fission, and chemical behavior of the atoms of this element were investigated. The Dubna results were in agreement with experiments performed at Berkeley. (auth)

36059 (YALE-1957-111) REACTIONS OF HOT TRITIUM ATOMS WITH METHANE AND HYDROGEN. Seewald, David Allan (Yale Univ., New Haven, Conn.). 1967. 119p. Dep. CFSTI.

Thesis.

The reaction of recoil tritium with methane was examined in a search for limitations of the recoil technique. Previously noted discrepancies in hot HT yields at high moderation were traced to the use of helium as a moderator. In accordance with predictions of the adiabatic principle, it appears that in pure or nearly pure helium, not all tritium atoms are neutralized, causing small ionic contributions to what are normally regarded as hot atom products. No such effects occur if moderators of lower ionization potential are used. The techniques thus developed made possible the exploration of the simple exchange reaction of atomic and molecular hydrogen over all possible energies. Accordingly, reactions of hot tritium with H_2, D_2, and HD were studied. It was found that tritium preferentially reacted with hydrogen when reacting with an equimolar deuterium-hydrogen mixture, while reaction with deuterium was favored in the reaction of tritium with HD. The data for all reactions were analyzed using the kinetic theory of hot reaction. Reactivity integrals and energy loss parameters were evaluated. Ratios of the values obtained for the $T + D_2$ and $T + CH_4$ reactions are in agreement with the corresponding ratios as independently derived from studies of the $T + (CH_4 - D_2)$ system. This provides an excellent check of the experimental method and the validity of the assumptions in the kinetic theory. Ratios of α values obtained are compared with theoretical values predicted by both soft-sphere and hard-sphere elastic collision models. Reactivity integrals for hydrogen are compared with corresponding quantities for $T + H_2$ and $T + D_2$ as calculated by Karplus, Porter, and Sharma using a quasi classical Monte Carlo method to compute cross sections as a function of energy. Agreement on absolute values was remarkably good for a first comparison of experiment and mechanistic theory in hot-atom chemistry. However, theoretical and experimental isotope effects show what appears to be a significant difference. (auth)

36060 (NP-tr-1564) PREPARATION OF CARRIER-FREE ^{35}S. Cifka, J.; Vins, V. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Translated by L. H. Sinclair for Atomic Energy Research Establishment, Harwell, Eng., from report UJV-1510. 35p. Dep. CFSTI. JCL $3.60 fs, $1.28 mf.

Literature on the methods of preparation of carrier-free ^{35}S is reviewed, and the results of laboratory tests on some of these methods are described. The Yugoslav method of sorption of ^{35}S on aluminum oxide has been chosen for routine production. The production apparatus and operational experience since 1960 are described. Separate sections are devoted to the measurement and decontamination of the ^{35}S activity. (56 references). (auth)

36061 TRITIUM LABELING OF SOLIDS AND LIQUIDS BY MERCURY-SENSITIZED PHOTOLYSIS. Gant, Preston L. (Continental Oil Co., Ponca City, Okla.). Trans. Amer. Nucl. Soc., 10: 77-8 (June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36062 QUANTITATIVE DEPOSITION OF $^{231,233}Pa$ USING A ZIRCONIUM CARRIER, NH_4F–NH_4Cl SYSTEM. Angel, A. C.; Szidon, R. D.; Wessman, R. A. (Tracerlab, Richmond, Calif.). Trans. Amer. Nucl. Soc., 10: 76-7 (June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36063 CONTRIBUTION TO THE TECHNIQUE OF CLUSTERS OF RADIOACTIVE IONS TO THE STUDY OF REACTIONS OF HOT ATOMS. FORMATION OF TRITIATED HYDROCARBONS IN THE COURSE OF THE IRRADIATION OF BUTANE BY T^+ IONS. Paulus, J. M. (Centre de Recherches Nucleaires, Strasbourg). Radiochim. Acta, 7: 141-52 (June 1967). (In French).

Tritium ions are generated in a specially designed mass spectrometer in order to study the reactions of these ions with gases at low pressure. Irradiation of n-butane at pressures from 10^{-2} to 10^{-1} mm Hg with 3 to 6000 eV T^+ ions led to the following labeled products: CH_3T, C_2H_5T, C_3H_7T, C_3H_7T, C_3H_5T, and $n\text{-}C_4H_9T$. The effect of a radical scavenger was investigated. The introduction of tritium into an organic structure results from two different mechanisms, involving either a tritium atom or a tritium ion. From the behavior of the helium-moderated system it was deduced that the tritiation of butane implied mainly a tritium atom, but the other labeled products were formed principally in the course of ion–molecule reactions. As a function of the ion energy, the yields of the products involving an atom–molecule mechanism reached a maximum value, whereas the yields of the other products increased with decreasing velocity of the ions. The substitution reaction $T + C_4H_{10} \rightarrow C_4H_9T + H$ is possible when the energy of the tritium atom lies between 3 and 10 eV. (auth)

36064 CHEMICAL EFFECTS OF NEUTRON-INDUCED NUCLEAR REACTIONS IN HALATES AND RELATED COMPOUNDS. I. (n,γ) REACTIONS IN VARIOUS BROMATES. Saito, Nobufusa; Ambe, Fumitoshi; Sano, Hirotoshi (Tokyo Univ. Inst. of Physical and Chemical Research, Tokyo). Radiochim. Acta, 7: 131-4 (June 1967).

The chemical state of radioactive bromine atoms after the $^{79}Br(n,\gamma)^{80m}Br$ and $^{81}Br(n,\gamma)^{82}Br$ reactions was investigated in twelve bromates. A correlation was found between the retention and the ionization potential of the $M^{(n-1)+}$ ion to M^{n+} where M^{n+} was the cation of the bromates as well as the crystal free space of the bromates. These correlations were explained on the basis of simplified models of the recoil process. The isotope effect, previously reported for alkali bromates, was confirmed in all the bromates studied. The cause of this effect was discussed with regard to the recently discovered isomer of ^{82}Br. (auth)

36065 CHEMICAL EFFECTS OF BROMINE ACTIVATED BY THE ISOMERIC TRANSITION $^{82m}Br \rightarrow {}^{82}Br$ IN BINARY ORGANIC MIXTURES. I. REACTIONS IN MIXTURES OF n-PROPYL BROMIDE AND METHANOL. Katsanos, Nicholas A.; Stamouli, Maria I. (Democritus Nuclear Research Centre, Athens). Radiochim. Acta, 7: 126-30 (June 1967).

An attempt was made to develop a quantitative treatment of the intermediate complex hypothesis in reactions of bromine, activated by the isomeric transition $^{82m}Br \rightarrow {}^{82}Br$, with liquid organic media. The analysis is based on the assumption that if a mixture of or-

ganic compounds is used the activated bromine forms complexes with both constituents of the mixture and that an equilibrium is established between the two complexes. Equations are derived by means of which the equilibrium constant and the probability of the complex to form an organic product on decomposition can be determined. These equations are applied to mixtures of n-propyl bromide and methanol at various molecular bromine concentrations and it is found that the experimental results are very well described by the equations derived. Variation in molecular bromine concentration had little effect on the equilibrium constant and the probability mentioned above. (auth)

36066 SZILARD–CHALMERS EFFECTS IN IODATES AND PERIODATES WITH ^{127}I AND ^{129}I. Bellido, A. V. (Univ. Nacional de San Augustin de Arequipa, Peru). Radiochim. Acta, 7: 122-6(June 1967).

Crystalline sodium iodates with ^{127}I and ^{129}I and $Na^{129}IO_3-Na^{127}IO_4$ mixtures were irradiated with neutrons in order to study the behavior of the activated ^{128}I and ^{130}I in the crystal lattice, after the nuclear reaction, and the rate of thermal annealing of the different radioactive fractions. A remarkable isotope effect was observed; and the experiments on crystalline mixtures showed that both activated iodine isotopes maintain their own behavior. Studies on the influence of the physical conditions of the pile irradiation and the samples were also carried out. (auth)

36067 CHEMICAL STATE OF RADIOIODINE FORMED BY FAST-NEUTRON ACTIVATION OF SOLID $CsIO_4$ AND $CsClO_4$. Dupetit, G. A. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Radiochim. Acta, 7: 167-8(June 1967).

In cesium periodate the distribution of three radioactive iodine isotopes were measured over three oxidation states; periodate, iodate, and iodide + iodine. All isotopes were determined in the same sample and the following nuclear processes were used: $^{127}I(n,\gamma)^{128}I$; $^{127}I(n,2n)^{126}I$; and $^{133}Cs(n,\alpha)^{130}I$. The distribution of ^{130}I was found to be strikingly similar to that of ^{128}I and of ^{126}I, which indicates that the type of the nuclear reaction and the value of the recoil energy play only a minor role in determining this distribution. Measurements were made for ^{130}I produced in cesium perchlorate by the $^{133}Cs(n,\alpha)^{130}I$ process. In this material almost one half of the radioactive iodine was found in the IO_4^- fraction. (D.H.M.)

36068 RETENTION AND ANNEALING IN SOLID $CsIO_3$ ACTIVATED WITH FAST NEUTRONS. Dupetit, G. A.; Aten, A. H. W. Jr. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Radiochim. Acta, 7: 165-6(June 1967).

A comparison of the retention of ^{130}I, prepared by the $^{133}Cs(n,\alpha)$ process, with the retention of ^{128}I and ^{126}I, obtained by the nuclear reactions $^{127}I(n,\gamma)$ and $^{127}I(n,2n)$, was made in cesium iodate. The annealing of the three isotopes in the $CsIO_3$ matrix was also compared. The annealing curves for ^{126}I and ^{128}I were quite similar. The annealing curves for ^{130}I had a similar shape and were found to lie between the curves of the other isotopes; however, the curve showed that at the start of the annealing the retention of ^{130}I rose more rapidly than that of ^{126}I and ^{128}I. (D.H.M.)

36069 ON THE INTERMOLECULAR ENERGY MIGRATION DURING IRRADIATION OF ALKYL BENZENES BY ACCELERATED T^+ IONS. Kuklin, Yu. S.; Firsova, L. P. Vestn. Mosk. Univ., Ser. II Khim., No. 1, 117-19(Jan.-Feb. 1967). (In Russian).

Excited energy transmission from the aliphatic hydrocarbon chain to the benzene ring following displacement of the H atom or the alkylbenzene alkyl group by hot T atoms was studied. The influence of C–C bond stability on the possibility of hot T replacement of alkyl groups in the side chain was evaluated. In order to avoid the influence of γ, n, and α radiolysis during alkylbenzene irradiation, a low energy (2.5-keV) T^+ ion was used in addition to the recoil T atom obtained from the $Li(n,\alpha)T$ reaction. Tabulated data are given on the activity distribution in the labeled products from irradiation of toluene, ethylbenzene, and butylbenzene by accelerated 2.5-keV T^+ ions for 30 min at 130°C. The experiments showed that a weak C–C bond increased the probability of bond rupture during hot T atom replacement of alkyl group and that the process of excited energy transmission from the side chain to the benzene ring is identical to that during γ radiolysis. (R.V.J.)

36070 PRODUCTION OF CARBON DIOXIDE COUNTER GAS FOR THE GAS ANALYSIS OF ^{14}C-LABELLED ORGANIC COMPOUNDS IN THE PROPORTIONAL REGION. Mlinko, S.; Gacs, I.; Szarvas, T. (Central Research Inst. for Chemistry, Budapest. Isotope Inst. of the National Atomic Energy Commission, Budapest). Acta Chim. Acad. Sci. Hung., 52: 359-64(1967).

Procedure and apparatus are described for the production of $^{14}CO_2$ counter gas from ^{14}C-labeled organic compounds. Combustion of the sample was effected in a stream of air in the presence of cobaltic oxide catalyst. Oxygen was absorbed from the air by copper placed in the combustion tube. The carbon dioxide was swept by nitrogen carrier gas through a manganous oxide absorber to attain the purity required for use as a counter gas. Active carbon dioxide was frozen out in the trap connected to the counter tube at atmospheric pressure. Nitrogen contained in the counter was removed by suction, CO_2 was evaporated, and the counter was filled up to atmospheric pressure from a carbon dioxide supply tank. The results of activity measurements were reproducible with microanalytical accuracy. No vacuum apparatus was required, and the analysis can be performed in a simple combustion apparatus as usual in the analysis of organic compounds. (auth)

36071 INFRARED DETECTION OF TRICHLOROMETHYL RADICAL IN SOLID ARGON. Andrews, Lester (Univ. of Virginia, Charlottesville). J. Phys. Chem., 71: 2761-2(July 1967).

Results of infrared spectral studies on the trichloromethyl radicals produced in reactions between lithium atoms and carbon tetrachloride, 51% ^{13}C-enriched carbon tetrachloride, or bromotrichloromethane in argon are reported. (J.G.B.)

Separation Processes

Refer also to abstracts 35915, 36062, 36183, 36204, 38608, and 38826.

36072 (AAEC/TM–368) A BRIEF SURVEY OF PROCESSES FOR HEAVY WATER PRODUCTION. Ryan, R. K. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Feb. 1967. 24p. Dep.

A brief review is given of methods for the production of nuclear grade heavy water, including water electrolysis, distillation, and chemical exchange processes. Canadian plants use the H_2O/H_2S process. Sufficient development of the NH_3/H_2 process has proceeded for its use industrially. Heavy water production as a by-product of established industries appears attractive provided a process matched to the feed supply is available. (auth)

36073 (ANL–7350) CHEMICAL ENGINEERING DIVISION RESEARCH HIGHLIGHTS, MAY 1966–APRIL 1967. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 111p. Dep. CFSTI.

Research progress is reported on: compact pyrochemical processes, volatility and fluidization processes, materials chemistry and thermodynamics, reactor safety, energy conversion, nuclear constants, and determination of burnup in fast reactor fuels. (M.C.G.)

36074 (BM–RI–7018) ELECTROREFINING YTTRIUM. Merrill, C. C.; Wong, M. M. (Bureau of Mines, Washington, D. C.). Sept. 1967. 10p.

Studies were made to determine the amenability of yttrium to fused-salt electrorefining in a controlled atmosphere. Tests were conducted in a $LiCl-YCl_3$ electrolyte system at 710°C. The major variables studied were the YCl_3 content of the electrolyte, from 1.7 to 13.4 mol%, and the initial cathode current density, from 410 to 1,630 A/ft^2. Vacuum distillation was employed to remove salt from the deposited metal. Metallic impurities, except for lithium, could be reduced to near or below their lower analytical limits, ranging from 10 ppM for Cu to 300 ppM for Ta; reduction of oxygen content, however, was accomplished only in metal produced from electrolytes with 5.4 mol% YCl_3 or less. Initial cathode current density had little effect on the purity of the product. (auth)

36075 (BNL–11576) REMOVAL OF IRON FROM MINE DRAINAGE WASTE WITH THE AID OF HIGH-ENERGY RADIATION. Steinberg, M.; Pruzansky, J.; Jefferson, L. R.; Manowitz, B. (Brookhaven National Lab., Upton, N. Y.). July 1967. 23p. Dep. CFSTI.

Preliminary experimental data are presented on the removal of ferrous iron from acid mine drainage by neutralization with limestone followed by ^{60}Co gamma radiation treatment. At a pH of approximately 5.7 after limestone neutralization and while agitating with air sparging, it was possible to decrease the dissolved ferrous iron content from 409 ppM to less than 1 ppM in a period of time relatively short with respect to no radiation treatment. Thus radiation treatment appears to act as a catalyst in promoting the removal of ferrous iron from mine drainage. The rate of ferrous iron removal seems to be proportional to the square root of the intensity indicating a chain oxidation mechanism, which would include a biradical chain termination step. The chain carrier may be hydroxyl radicals. An experimental G value of 148 was obtained at a radiation intensity of 20,000 rads/hr and a rate of 45 ppM of ferrous iron removal per minute was obtained at an intensity of 4.3 megarads/hr. Based on this experimental data, two irradiation processes are described. ^{60}Co is indicated for a low-intensity, longer holdup time system, while an electron accelerator or a high intensity isotopic source is indicated for a very rapid re-

moval and low holdup process. An optimization between tank holdup and radiation source cost can be made. Further optimization and process development in addition to experimental studies to improve the yield are required to further evaluate the radiation treatment process for comparison with the limestone-lime treatment process. An important favorable factor may be that the limestone-radiation process yields a readily separated crystalline precipitate while the limestone-lime treatment usually produces a flocculent precipitate that is difficult to handle and dispose. (auth)

36076 (BNWL-440) SOLVENT EXTRACTION PURIFICATION OF ^{233}U WITH DI-SEC-BUTYL PHENYLPHOSPHONATE. Phillips, J. F. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1967. Contract AT(45-1)-1830. 11p. Dep. CFSTI.

A solvent extraction process for separating uranium from thorium, plutonium, polonium, iron, and cobalt has been developed. The extractant is di-sec-butyl phenylphosphonate dissolved in carbon tetrachloride. A flowsheet for the process is given. (auth)

36077 (BNWL-476) CHEMICAL SAFETY FOR ^{99}Tc RECOVERY BY ANION EXCHANGE. Final Report. Van Slyke, W. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1967. Contract AT(45-1)-1830. 36p. Dep. CFSTI.

The chemical self heating hazards for a proposed technetium-99 recovery process were thoroughly analyzed experimentally and by digital computer simulation. The important factors found were reaction kinetics and stoichiometry, flow rate, and system dimensions. Process thermal behavior is presented graphically for each ion exchange material examined, and the possible process hazards and their prevention are discussed. (auth)

36078 (CEA-R-3225) ETUDE DES ETATS D'EQUILIBRE ET DES REGIMES TRANSITOIRES DES CONCENTRATIONS D'UNE BATTERIE D'EXTRACTION LIQUIDE-LIQUIDE DE L'URANIUM. (Study of Equilibrium States and of Transient Regimes in the Concentrations of a Liquid-Liquid Uranium Extraction Battery). Degryse, Michel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1967. 32p. (In French). Dep.

Thesis.

Exchange phenomena in a liquid-liquid uranium exchange battery are described and the graphical MacCabe-Thiele method used for determining the equilibrium profiles in the stages. A linear model for uranium is described for a nominal equilibrium point, and it is applied to a particular extraction battery using simulation methods and an analog computer. The transient states for uranium were determined for various perturbations of the entrance parameters; concentration, flow rates and TBP content of the solvent. (auth)

36079 (CEA-R-3246) DISSOLUTION CONTINUE DES COMBUSTIBLES NUCLEAIRES IRRADIES. (Continuous Dissolution of Irradiated Nuclear Fuels). Michel, Pierre; Talmont, Xavier; Tarnero, Maurice (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). May 1967. 94p. (In French). Dep.

Equations for the calculation of the fuel concentration of the solution flowing out of a pot dissolver were written. Nitric acid feed flow rates were calculated in order to obtain an adjusted solution when starting or stopping a dissolution, or when changing the number of rods introduced per hour. Some transient states brought on by perturbations were studied: (a) sudden change in nitric acid flow rate; (b) continuous drift of the latter; (c) sudden change in nitric acid feed concentration; and (d) transition from one fuel concentration to another by changing the flow rate of nitric acid feed. It was shown that some transient states cannot be solved by means of general equations. Computer calculation programs would probably be more useful. (auth)

36080 (EURAEC-1868) REPROCESSING OF IRRADIATED FUELS. Quarterly Report No. 28, January 1-March 31, 1967. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Contracts 006-65-7-RCIB(RD); 016-65-1-RAP-B. 21p. (EUR-3372). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

Work was continued on evaluating the potential of chlorine fluorides for reprocessing of mixed oxide fuel. Thermodynamic research provided estimates of plutonium hexafluoride concentrations that should prove stable in the presence of the reagents in question. A number of tests on the chemical decanning of stainless steel with the $HF-O_2$ mixture were carried out. This operation requires satisfactory control of the reaction temperature. Fluid-bed tests were effected: pure uranium dioxide was atomized with oxygen, and the resulting uranium octoxide was hydrofluorinated (4 kg scale). At the same time, similar tests were carried out in a small fluid bed on plutonium mixtures. These reactions were followed by fluorination with chlorine monofluoride. Work continued on constructing the plant for reprocessing research (cold subassembly processing unit, hot thermobalance, hot semi-pilot). (auth)

36081 (LFEN-NI-33) ESTUDOS SOBRE AS PERDAS DE URANIO NOS MINERIOS SUJEITOS A ACCAO DA AGUA DAS CHUVAS. (Investigation of U Losses in Ores Exposed to the Action of Rainwater). Pich, H. Carreira; Alves, Marilia; Ramos, M. Antonieta; Ferreira, R. Hasse; Elias, J. Trindade; da Conceicao, E. Henriques (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1967. 75p. (In Portuguese). Dep.

The effect of rainwater leaching was studied on four U ores. The results gave no quantitative idea of possible U losses but indicated that some ores lose U and others resist the action of water. Some parallellism was noted between the ease of dissolution of U and the S concentration of the ores. Mineralogic and petrographic characteristics of the ores studied are given and the results obtained are shown graphically and in tables. (J.S.R.)

36082 (NP-16720) PURIFICACION DE NITRATO DE URANILO EN COLUMNA EXPERIMENTAL CON FOSFATO DE TRIBUTILO (TBP). (Purification of Uranyl Nitrate in Experimental Column by TBP). Rivero Medina, Arturo A. (Instituto Politecnico Nacional, Mexico City. Escuela Superior de Ingenieria Quimica e Industrias Extractivas). 1963. 56p. (In Spanish). Dep.

Thesis.

A system is proposed for the extraction and refining of uranyl nitrate with a probable purity of 99.9%. The design of the system in its constituent parts is presented. (J.S.R.)

36083 (NP-16940) SEPARATION DES ELEMENTS TRANSPLUTONIENS DU PLUTONIUM IRRADIE. I. EQUIPMENT. (Separation of Transplutonium Elements From Irradiated Plutonium. I. Equipment). Berger, R.; Baudet, M.; Gradaive, J.; Hecq, R. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb. 1964. 48p. (In French). Dep.

A detailed description is given of the equipment used for the separation of transplutonium elements from irradiated aluminum-plutonium fuel elements. Protective equipment and special equipment for chemical treatment and measurement are described. (P.C.H.)

36084 (ORNL-4117) HOT-CELL EVALUATION OF THE GRIND-LEACH PROCESS. I. IRRADIATED HTGR CANDIDATE FUELS: PYROCARBON-COATED $(Th,U)C_2$ PARTICLES DISPERSED IN GRAPHITE. Flanary, J. R.; Goode, J. H. (Oak Ridge National Lab., Tenn.). Aug. 1967. Contract W-7405-eng-26. 27p. Dep. CFSTI.

The grind-leach process, an aqueous head-end method developed for HTGR candidate fuels, was evaluated in hot-cell experiments with irradiated fuel specimens composed of pyrocarbon-coated $(Th,U)C_2$ particles dispersed in graphite. Fine-grinding of the GAIL-3A and GAIL-3B fuel compacts (supplied from General Atomic's In-Pile Loop irradiation studies) and ORNL experimental AVR fuel spheres to -100 mesh, followed by multiple leaching with boiling 13M HNO_3, failed to produce near-quantitative recovery of the fuel values; as much as 4.5% of the uranium and 6.9% of the thorium appeared as non-leachable losses in the graphite waste. (The grind-leach method normally provided 99.7% recovery of heavy metals from similar unirradiated fuel samples.) Retention of uranium, thorium, and fission products in the residue was uniformly high for all leached fuel specimens that were irradiated to burnups of 9,600 to 41,200 MWd per metric ton of U + Th. Although the nonleachable fractions of heavy metals and fission products appeared to be independent of the known irradiation histories of the test fuels, the results implied that the fraction resistant to leaching may be bound in the pyrocarbon coating, perhaps by the mechanisms of diffusion and fission recoil. Because of incomplete recovery of the fuel values, and the large fraction of heat-generating fission products that remains unleached from the graphite waste, the grind-leach method does not appear promising for processing fuels that contain pyrocarbon-coated carbide particles. However, it may prove useful in processing other coated-particle fuels that are currently being developed. (auth)

36085 (SCCI-19) SEPARATION DES ELEMENTS TRANSPLUTONIENS DU PLUTONIUM IRRADIE. II. RESULTATS D'ESSAIS. (Separation of Transplutonium Elements From Irradiated Plutonium. II. Study Results). Berger, R.; Chesne, A. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). June 1965. 24p. (In French). Dep.

A detailed description is given of the chemical methods used for the separation of transplutonium elements from irradiated aluminum-plutonium fuel elements. The experimental observa-

tions and results obtained are indicated for each of the successive chemical operations. (P.C.H.)

36086 PROBLEMS OF UTILIZING RADIOACTIVE PROCESS WASTE. Ullmann, H. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie, 10: 1-8(Jan. 1967). (In German).

The problems of utilizing radioactive process waste are reviewed. The character and amount of radioactive process waste produced per year are summarized. The methods used for separation of fission products and applications of various fission products are described. Possible future uses of waste products are indicated. (66 references.) (J.S.R.)

36087 RAPID RADIOMETRIC METHOD FOR DETERMINING DISTRIBUTION COEFFICIENTS OF ZIRCONIUM AND HAFNIUM DURING EXTRACTION. Perovskii, A. P.; Sokolov, E. N. Radiokhimiya, 9: 258-61(1967). (In Russian).

In evaluating the separation of Hf from Zr by solvent extraction, numerous samples must be analyzed by cumbersome, time-consuming methods. A simple method of rapidly determining the distribution coefficients of Zr and Hf involves the simultaneous use of the two radioactive tracers, ^{95}Zr and ^{181}Hf. The ^{95}Zr activity must be separated from its ^{95}Nb daughter. The beta decay of ^{95}Zr shows a low probability for the emission of a conversion electron, while the 133- and 136-keV gamma transitions in ^{181}Ta (the daughter of ^{181}Hf) have large internal conversion coefficients (0.5 and 1.5 respectively). Hence, it is possible to distinguish these two radioactive isotopes by beta–gamma coincidence counting. The results obtained by the use of this technique agreed well with data obtained by other methods of analysis. The error in determining the distribution coefficients of Zr and Hf over a wide variation in concentration did not exceed 20%. (TTT)

36088 RADIOCHEMICAL ISOLATION. IV. SEPARATION OF THE TARGET MATERIAL FROM THE PRODUCTS OF CERIUM FISSION. Mastalka, A.; Chalkin, V. A.; Lebedev, N. A. (Inst. of Nuclear Research, Prague. Joint Inst. for Nuclear Research, Dubna, USSR). Collect. Czech. Chem. Commun., 32: 1604-8(Apr. 1967). (In German).

The separation of macromasses of Ce from mixtures of its fission products by distribution chromatography using a stationary organic phase was investigated. Nitromethane, dibutyl phosphate, bis(2-ethylhexyl) orthophosphate, and tributyl phosphate were the organic phases investigated. Study showed that low nitric acid concentrations favor the separation of the Ce. Tributyl phosphate and the bis(2-ethylhexyl) orthophosphate both gave satisfactory results in the separation. With dilute nitric acid the Ce together with Pr was eluted from the column at the very beginning of the elution. Cs, Ba, and La were eluted with 14M HNO_3. (J.S.R.)

36089 A RAPID METHOD FOR RADIOCHEMICAL ANALYSIS OF ^{90}Sr AND THE RARE EARTHS FROM SEAWATER BY EXTRACTION TECHNIQUES. Major, W. J.; Lee, K.; Wessman, R. A.; Peters, R. (Tracerlab, Richmond, Calif.). Trans. Amer. Nucl. Soc., 10: 71-2(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36090 SEPARATION AND PURIFICATION OF URANIUM AND THORIUM FROM ORGANIC LIQUIDS ON AN ANIONIC EXCHANGE RESIN. Meyer, Walter (Kansas State Univ., Manhattan); Nayak, Manel N. Trans. Amer. Nucl. Soc., 10: 156-7(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36091 FISSION-PRODUCT AND ACTINIDE DISTRIBUTION DURING REPROCESSING OF IRRADIATED UO_2 BY THE FLUIDBED FLUORIDE VOLATILITY METHOD. Chilenskas, A. A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 157(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36092 RAPID MATRIX REMOVAL IN ACTIVATION ANALYSIS BY ISOTOPIC ION EXCHANGE. Peterson, S. F.; Tera, F.; Morrison, G. H. (Cornell Univ., Ithaca, N. Y.). Trans. Amer. Nucl. Soc., 10: 91(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36093 RAPID SEPARATION OF RADIONUCLIDES BY SPONTANEOUS ELECTRODEPOSITION ON METALLIC MERCURY. II. METALLIC MERCURY–METAL ION SYSTEMS. Okashita, Hiroshi (Japan Atomic Energy Research Inst., Tokyo). Radiochim. Acta, 7: 85-9(June 1967).

The spontaneous electrodeposition of various metal ions on metallic mercury was studied using an ultrasonic agitation technique. It was confirmed that the elements which have more positive redox potentials than that of mercury generally deposit on metallic mercury spontaneously. Gold, platinum, palladium, silver, iridium, osmium, tellurium, and selenium were transferred to mercury in solutions of NH_4OH, KSCN, HNO_3, H_2SO_4, HCl, and $HClO_4$. Utilizing the difference in fractions of separation for metal ions in appropriate reaction media, methods of separating carrier-free radioactive silver from irradiated palladium, tellurium from irradiated uranium, and gold from irradiated platinum with a satisfactory degree of separation were developed. (auth)

36094 RAPID SEPARATION OF RADIONUCLIDES BY SPONTANEOUS ELECTRODEPOSITION ON METALLIC MERCURY. I. METALLIC MERCURY–MERCURY ION SYSTEM. Okashita, Hiroshi (Japan Atomic Energy Research Inst., Tokyo). Radiochim. Acta, 7: 81-5(June 1967).

A mercury–mercury ion system was studied in order to obtain some fundamental information on spontaneous electrodeposition using mechanical and ultrasonic shaking techniques. It was confirmed that the mercury–mercury ion exchange reaction under the experimental conditions followed the exponential law of the heterogeneous exchange reaction. The rate of exchange reaction was found to be much faster for the ultrasonic agitation than for the mechanical shaking. For instance, the half-exchange time in 1N HNO_3 solution was 2.5 sec for the former and 4 min for the latter. It was also shown that the ultrasonic agitation was very effective in rapid separation by spontaneous electrodeposition on metallic mercury. (auth)

36095 SEPARATION OF IODINE FROM FISSION PRODUCT SOLUTIONS WITH SILVER CHLORIDE ON SILICA GEL. Lieser, K. H.; Hild, W. (Technische Hochschule, Darmstadt, Ger.). Radiochim. Acta, 7: 74-7(June 1967). (In German).

The iodine produced by the fission of uranium was separated in a carrier-free form from nearly all other fission products by the use of columns filled with silver chloride on silica gel. The yields of carrier-free iodine varied about 90%. By adding very small amounts of carrier the yield could be increased to about 98 to 99% with better reproducibility. (auth)

36096 SEPARATION OF SCANDIUM AND MANGANESE BY ION EXCHANGE CHROMATOGRAPHY. Belyavskaya, T. A.; Alimarin, I. P.; Brykina, G. D. Vestn. Mosk. Univ., Ser. II Khim., No. 1, 53-6(Jan.-Feb. 1967). (In Russian).

Sorption of Sc and Mn by KU-2 and AV-17 anion exchange resins from aqueous acetone solutions containing sulfuric, hydrochloric, and nitric acids was studied under static and dynamic conditions. (R.V.J.)

36097 INVESTIGATIONS ON ION-EXCHANGE EQUILIBRIA WITH RADIOACTIVE TRACER METHOD. IX. THEORY AND USE OF EXTRACTIVE ION-EXCHANGE IN THE SEPARATION OF SOME LANTHANONS. Lengyel, T. (Inst. of Isotopes, Budapest). Acta Chim. Acad. Sci. Hung., 52: 375-90(1967).

Starting with results of static equilibrium measurements, investigations were made concerning the separation of europium, terbium, and thulium by means of extractive ion exchange. The theory and practical aspects of the separation technique are briefly discussed. (auth)

36098 CONCERNING INFLUENCE OF SURFACE-ACTIVE AGENTS ON BITUMINIZATION OF RADIOACTIVE WASTES. Kul'bashnaya, M. V.; Fomin, Yu. K. At. Energ. (USSR), 22: 397-9(May 1967). (In Russian).

During bituminization of radioactive wastes the presence of surface-active agents causes structuring of systems and an increase in the viscosity. For the bitumin BN-3 with a softening temperature of 50°C and dry residue, separated from iron hydroxide pulp by the oil flotation method, for which the presence of surface-active agents of the petroleum sulfoacid and a synthetic detergent in the quantity of 30 to 50% is characteristic, the dependence of the viscosity on the temperature T and the concentration of the filler containing 45% surface-active agent, when the concentration interval of the surface-active agent in the compound is 0 to 27%, is described by the equation $\lg \eta = (15.80 - 8.14C) - (6.35 - 4.33C)\lg T$, where η is the viscosity in centipoise and C is the concentration of the filler, expressed in tenth parts of the compound weight. The maximum permissible quantity of surface-active agent in the compound is 24%; with this the compounds can be extracted in the course of 2 to 3 hrs at 140 to 190°C without significant decrease in the viscosity or difficulty of discharge of the bitumin compound from the apparatus. (tr-auth)

36099 INVESTIGATIONS ON ION-EXCHANGE EQUILIBRIA WITH RADIOACTIVE TRACER METHOD. X. APPLICATION OF THE GRADIENT ELUTION TECHNIQUE IN EXTRACTIVE ION-EXCHANGE SEPARATION. Lengyel, T. (Inst. of Isotopes, Budapest). Acta Chim. Acad. Sci. Hung., 52: 391-6(1967).

The separation of terbium and thulium is described by means of

extractive ion exchange combined with the gradient elution technique. Theoretical aspects of the method are discussed, and a graphic procedure to predict the peak positions in the extract of the eluate is presented. (auth)

36100 DECONTAMINATING LOW-ACTIVITY EFFLUENTS BY ELECTRODIALYSIS WITH ION-EXCHANGE MEMBRANES. Rauzen, F. V.; Dudnik, S. S.; Gutin, E. I. At. Energ. (USSR), 22: 393-6(May 1967). (In Russian).

The possibility of using electrodialysis for decontamination of low-activity effluents was investigated. It was shown that electrodialysis can be used for the purification of PDK solutions, containing less than 100 mg/l salt. (PDK means the maximum permissible concentration of radioisotopes in water of open reservoirs and sources of water works, established by the sanitary administrator.) It can be used for the decontamination of very concentrated solutions. If in the waste water, there is more than 5 g/l salts, then a process of desalting with simultaneous production of acids and bases is recommended. (tr-auth)

36101 PURIFICATION OF PLUTONIUM BY ANION EXCHANGE IN NITRIC ACID. Kaya, Akira (Atomic Fuel Corp., Tokyo); Kudo, Hisao; Shirahashi, Junji; Suzuki, Susumu. J. Nucl. Sci. Technol. (Tokyo), 4: 289-92(June 1967).

$Pu(NO_3)_4$ solution stored after separation from U and fission products by anion exchange and containing a large amount of hydroxylamine hydrochloride used as eluent, was repurified by anion exchange. Radiochemical determination of Pu isotopes, both in the purified Pu solution and waste solution, was also studied. Pu(IV) was adsorbed on the anion-exchange resin (Dowex-1 × 2, 200 to 400 mesh) in 7.2 N HNO_3 at about 60°C, and was eluted with 0.35 N HNO_3. Pu was recovered with a yield of 97%. High-purity Pu was obtained, leaving ^{241}Am in the waste solution. (auth)

36102 STUDIES OF ACTINIUM(III) IN VARIOUS SOLUTIONS. I. SEPARATION AND PURIFICATION OF ^{228}Ac IN ^{228}Ra SOLUTIONS BY SOLVENT EXTRACTION METHOD. Sekine, Tatsuya; Koike, Yasuaki; Sakairi, Mitsuo (Tokyo Coll. of Science). J. Nucl. Sci. Technol. (Tokyo), 4: 308-11(June 1967).

A solvent extraction method using a mixture of 0.1M thenoyltrifluoroacetone and 0.1M tributyl phosphate in carbon tetrachloride was developed for the separation and purification of ^{228}Ac in ^{228}Ra solutions. The ^{228}Ra was first purified by a preliminary extraction cycle. The ^{228}Ac that accumulated in this ^{228}Ra fraction after the purification was separated and purified by a second solvent extraction cycle. Since commercially available ^{228}Ra solution very often contains ^{226}Ra, the γ decay products of ^{226}Ra have to be carefully removed. The ^{228}Ac thus prepared was found to be pure enough for use as tracer. (auth)

36103 IMPROVED METHOD FOR REPROCESSING ALUMINUM-CONTAINING SPENT NUCLEAR FUELS. (to U. S. Atomic Energy Commission). British Patent 1,076,655. July 19, 1967. Priority date Mar. 31, 1964, United States.

A method is described for reprocessing Al-containing spent nuclear fuels by dissolving the fuels in a molten salt solvent of a composition substantially 67 KF–21 ZrF_4–12 AlF_3 mole % until the AlF_3 content of the salt is no greater than 32 mole %. The dissolution is carried out at a temperature of 600°C or less while anhydrous HF is passed through the melt. The volatile UF_6 is recovered by cooling the UF_6 to a temperature of about 100°C and absorbing the cooled product on a bed of NaF pellets to separate the fuel values from the fission products. Then the bed is heated to a temperature of 400°C to remove the UF_6. (B.L.M.)

36104 METHOD FOR PROCESSING ALUMINUM-CONTAINING NUCLEAR FUELS. (to U. S. Atomic Energy Commission). British Patent 1,076,656. July 19, 1967. Priority date Mar. 31, 1964, United States.

A method is described for dissolution of Al-containing nuclear fuels and for recovery of U values from the melts. The fuels are dissolved in a molten salt solution consisting of 59 to 61 mole % KF and 39 to 41 mole % ZrF_4 at a temperature no greater than 600°C while anhydrous HF is passed through the melt. Fluorine gas is then passed through the melt while the temperature is maintained at 575°C to convert the dissolved fuel values to the volatile hexafluorides. The volatilized UF_6 is cooled to a temperature of about 100°C and absorbed on a bed of NaF pellets to separate the UF_6 from the fission products. The UF_6 is then removed from the bed by heating to a temperature of above 400°C. (B.L.M.)

36105 STRUCTURAL EFFECTS OF β-DIKETONES ON THE ENHANCEMENT OF EXTRACTION OF URANIUM BY THE SYNERGIST TRIBUTYL PHOSPHATE. Batzar, Kenneth. New York City, City Univ. of New York, 1966. 160p.

Thesis.

Conditions necessary for obtaining and improving synergic enhancement of the solvent extraction of U with β-diketones as chelating agents and tributyl phosphate (TBP) as synergist were determined. The nature of the synergic complex found and how the synergic agent is bonded in this complex were also studied. Data were accumulated for various extractions where the structure of the β-diketone was changed so that possible sites for addition of the synergist in the complex were changed. Extraction studies were carried out with acetylacetone, benzoylacetone, benzoyltrifluoroacetone, dibenzoylmethane, furoyltrifluoroacetone, thenoylacetone, thenoyltrifluoroacetone, and 4,4,4-trifluoro-2-methyl-1-(2-thienyl)-1,3-butanedione, all in the presence and absence of TBP. The above β-diketones were chosen so that all possible sites for interaction of the synergist to the β-diketone would be varied. Synergic enhancement occurred in all cases, and it was concluded that TBP probably bonds directly to U. This conclusion coupled with the work of Healy concerning the effect of various organic diluents on enhancement of extraction, and solubility studies of $UO_2T_2(H_2O)_x$ in these diluents, leads to the following equation for the explanation of the synergic phenomenon: $UO_2T_2(H_2O)_x + x\,S \rightleftharpoons UO_2T_2S_x + x\,H_2O$, where T^- is the enolate ion of a β-diketone and S is synergist. The stoichiometry of the extracted species was arrived at by obtaining distribution coefficient data as the concentration of β-diketone or synergist was altered. The most common extracted species is generally represented by UO_2T_2S. This species is rendered less hydrophilic with the replacement of a water molecule by TBP and is more soluble in the organic phase. Equilibrium constants for the following reactions were obtained for all the aforementioned β-diketones: $UO_2^{2+} + 2\,HT \rightleftharpoons UO_2T_2 + 2\,H^+$, $UO_2^{2+} + 2\,HT + S \rightleftharpoons UO_2T_2S + 2\,H^+$, and $UO_2T_2 + S \rightleftharpoons UO_2T_2S$. Interpretation of the values of these equilibrium constants led to the conclusions that the extraction of uranium by any β-diketone should be enhanced by the addition of TBP and that the synergic extraction of U is directly proportional to the acid strength of the β-diketone and to the degree of π bonding between the metal and the β-diketone. Improvement of the extraction of U in the presence of TBP may be brought about by choosing a β-diketone with a low pK_D value containing terminal R-groups capable of increasing the degree of π bonding with U. Work performed with Th ion shows that ThT_4 may not be coordinately saturated because TBP formed a species, ThT_4S, with 4,4,4-trifluoro-2-methyl-1-(2-thienyl-1,3-butanedione. This β-diketone lacks any site for β-diketone–synergist interaction. (Disser. Abstr.)

EARTH SCIENCES

Geology

Refer also to abstracts 36338 and 36417.

36106 (CLOR-63/D) $^{144}Ce + ^{144}Pr$, ^{137}Cs AND ^{90}Sr CONTENT IN SOIL IN POLAND IN THE YEAR 1964. Grzybowska, D. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1967. 26p. Dep.

Radiochemical analyses of surface-layer samples (0 to 5 cm) of soil from the vicinity of Warsaw in 1964 showed an average content of 89 mCi to Ce-144 + Pr-144/km^2, 24 mCi Cs-137/km^2 and 20 mCi Sr-90/km^2. Among the most frequently occurring in Poland's 4 kinds of soil, silt presented the highest radioactivity. Detailed results of radionuclide content as well as additional determinations (incineration coefficient, the total sum of exchangeable bases, pH, calcium and potassium content) are presented in tables and diagrams. The results of determination in layer samples from 0 to 30 cm showed that the surface layer (0 to 5 cm) contains about 90% of radioelements detected in the 0 to 30 cm layer. (auth)

36107 UNDERGROUND DISPOSAL OF ^{85}Kr FROM NUCLEAR FUEL REPROCESSING PLANTS. Tadmor, Jacob; Cowser, K. E. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 159-60(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36108 NEUTRON DIE-AWAY EXPERIMENT FOR LUNAR AND PLANETARY SURFACE ANALYSIS. Mills, W. R.; Givens, W. W.; Caldwell, R. L. (Mobil Oil Corp., Dallas, Tex.). Trans. Amer. Nucl. Soc., 10: 33(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36109 A METHOD FOR THE ANALYSIS OF PULSE-HEIGHT SPECTRA CONTAINING GAIN SHIFT AND ZERO-DRIFT COMPENSATION. Trombka, J. I. (Goddard Space Flight Center, Greenbelt, Md.); Schmadebeck, R. L. Trans. Amer. Nucl. Soc., 10: 33-5(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36110 POTENTIAL OF THE LITHIUM-DRIFTED SOLID-STATE DETECTOR IN X-RAY-FLUORESCENCE ANALYSIS. Heath, R. L. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc., 10: 35-6(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36111 SNOW-EVAPORATION REDUCTION: MIGRATION OF EVAPORATION SUPPRESSANTS THROUGH SNOW. Essington, Edward H. (Hazleton-Nuclear Science Corp., Palo Alto, Calif.); Smith, James L. Trans. Amer. Nucl. Soc., 10: 77(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36112 THE STATE OF THE ART IN ^{14}C DATING. Libby, W. F. (Univ. of California, Los Angeles). Trans. Amer. Nucl. Soc., 10: 20(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36113 A CONTRIBUTION TO THE THEORY OF RADIOACTIVE EMANATION PROPAGATION IN THE SURFACE LAYER OF THE ATMOSPHERE. Belekhova, N. G.; Karol', I. L. (Inst. of Applied Geophysics, Moscow). Izv. Akad. Nauk SSSR, Fiz. Atmos. Okeana, 3: 733-41(July 1967). (In Russian).

The one-dimensional problem of vertical propagation of radioactivity in the soil, air, and in the boundary layer of the atmosphere is considered for the Shvetz-Yudin model of the vertical turbulent diffusion coefficient K_z changing with height. It was found that this problem is quasi-stationary for thoron (Rn-220). The change of K_z in the surface layer of the atmosphere has no influence on the exhalation rate of radon, and it has small influence on the exhalation rate of thoron under the considered assumptions. The formulas obtained are applied to the estimates of the daily variation of K_z in the first several meters above ground and to thoron exhalation rate using the published data of thoron concentration measurements in the surface layer of the atmosphere. (tr-auth)

36114 CONTENT OF RADON, RADIUM, URANIUM, AND MESOTHORIUM IN MINERAL WATERS OF THE ROSTOV PROVINCE. Kagan, M. S. (Scientific Research Inst. of Health Resort Study and Physiotherapeutics, Pyatigorsk, USSR). Geokhimiya, No. 7, 842-9(July 1967). (In Russian).

Radioactive water contents of the province are identified, the interconnection between the content of some radioactive isotopes and the chemical composition of the spring has been established, and the confinement of radioactive isotopes to definite water-bearing horizons and hydrogeological structures has been fixed. (auth)

36115 THE INTERPRETATION OF URANIUMMETRICAL ANOMALIES IN ARID REGIONS USING THE ISOTOPIC RATIO $^{234}U/^{238}U$. Syromyatnikov, N. G.; Ibraev, R. A.; Mukashev, F. A. (Inst. of Geological Sciences, Alma-Ata, USSR). Geokhimiya, No. 7, 834-41(July 1967). (In Russian).

Studies were made of uranium anomalies in arid regions using the isotopic ratio of $^{234}U/^{238}U$ of migrating uranium in surface formations. The samples with a normal mineralization and with abnormal content of uranium of non-metallic origin were found to have an identical ratio (with a negligible isotopic anomaly), while an abnormal deviation of the ratio from the normal values was observed in uranium dispersion aureoles. The positive, negative or complex anomalies were displayed according to the type of the ore. The intense evaporation of the arid area favorable for uranium concentration in near-surface formations, created favorable conditions for the isotopic-uranium measuring method using the ratio $^{234}U/^{238}U$. (auth)

36116 THE INVESTIGATION OF THE ABUNDANCE AND DISTRIBUTION OF URANIUM IN SOME MINERALS AND ROCKS BY THE NEUTRON ACTIVATION TECHNIQUE WITH THE REGISTRATION OF FRAGMENT FISSION TRACKS. Komarov, A. N.; Shukolyukov, Yu. A.; Skovorodkin, N. V. (Lab. of Pre-cambrian Geology, Leningrad). Geokhimiya, No. 7, 763-76(July 1967). (In Russian).

Minerals of the garnet group and acid igneous rocks were investigated using a sensitive technique of registration of tracks formed by the fragments of induced fission of uranium. Uranium is found to enter the garnets, in crystal structure of the minerals in the amounts of 10^{-8} to 10^{-5} gram per gram, in microinclusions, and in uranium bearing film mineralization in fractures. In granites the uranium is found to be confined to accessory minerals and dispersed uranium mineralization distributed between rock forming minerals and their residual sedimentations. The fixation of uranium in the solid phases is assumed to occur at the end of magnetic melt crystallization. (auth)

36117 RADIOACTIVITY AND ABSOLUTE AGE OF THE YOUNG VOLCANIC ROCKS. Cherdyntsev, V. V.; Kislitsina, G. I.; Kuptsov, V. M.; Kuz'mina, E. A.; Zverev, V. L. (Geological Inst., Moscow). Geokhimiya, No. 7, 755-62(July 1967). (In Russian).

The volcanic rocks and some other samples from Kamchatka, Italy and Caucasus (Quaternary volcanism) were investigated. The enrichment of volcanic rocks in radioactive elements is in agreement with the sequence U > Ra > Th and the uranium isotope separation is confirmed. In some cases the rocks are enriched in protactinium rather than in uranium. The migration of radium is suggested to take place during the postvolcanic stage since the Quaternary volcanic rocks were often observed to have a nonequilibrium content of radiothorium. The low value of ionium-uranium ratio of some Quaternary volcanic rocks can be used as a new method of the absolute age upper limit determination. For the certain Quaternary volcanic rocks in the Caucasus this age is not older than 13 thousands years. (auth)

36118 RADON ^{222}Rn AND THORON ^{220}Rn IN SOIL AIR OVER FAULTS. Israel, H. (Technische Hochschule, Aachen); Bjoernsson, S. Z. Geophys., 33: 48-64(Jan. 1967).

The concentration of Rn and thoron in soil air was surveyed in several transects over faults in the vicinity of Aachen. The purpose of this survey was to clear up the mechanism of emanation enrichment in soil air over faults. It was possible to distinguish 2 different kinds of the observed anomalies: first, anomalies in both Rn and thoron over the fault and a similar variation of both emanations throughout the transect; second, a Rn anomaly over the fault, accompanied by no or only a weak thoron anomaly. The first type is most likely caused by an enrichment of parent nuclides of the emanations in the overburden and not by migration of the emanations. The second type was only encountered in dry and permeable soil and might be caused by an upward migration of Rn. Supplementary Rn and thoron surveys were carried out at the brine fault in Bad Nauheim, where a strong Rn anomaly was known

to exist. The location and intensity of the observed Rn anomaly was in good agreement with previous results. The thoron content of soil air was found to be consistent with the findings elsewhere. The anomaly of the soil air Rn content in Bad Nauheim was discussed. (BBB)

36119 MODEL STUDIES ON THE PENETRATION OF FALLOUT IN VARIOUS SOILS. Henzel, N. (Battelle-Institut, Frankfurt am Main); Strebel, O. Z. Geophys., 33: 33-47(Jan. 1967). (In German).

The penetration of slightly soluble and soluble artificially constituted fallouts into various soils was investigated taking into consideration particle size, solubility, and radiation characteristics of radionuclides of fallout from nuclear explosions. The experiments with slightly soluble model fallout (quartz powder ranging from coarse silt to fine sand particle size labeled with $^{95}Zr/^{95}Nb$ or $^{90}Sr/^{90}Y$) were carried out in a lysimeter filled with sandy or humus type loamy soil. About 400 l/m^2 distilled water (corresponding to the mean annual amount of percolation water) was sprinkled onto the surface of either lysimeter charge. Such irrigation did not result in a noticeable displacement of the fallout to the depth of the tube nor in a subsequent reduction of the dose rate above the soils tested. Solutions of the nuclide pairs $^{137}Cs/^{137m}Ba$, $^{89}Sr/^{89m}Y$, $^{90}Sr/^{90}Y$, $^{144}Ce/^{144}Pr$, and $^{95}Zr/^{95}Nb$ served as models for soluble fallout. Two types of experiments were carried out with these patterns: percolation experiments in glass columns, and shaking experiments to determine the capacity of sandy soil, humus sandy soil, calcareous sandy soil, loamy soil, humus loamy soil, calcareous loamy soil, silty clay soil, and clay soil to take up ions of these radioelements. With $^{95}Zr/^{95}Nb$ the soluble activity penetrated into the sandy soils to about 15 cm, but into the other soils to a few centimeters only. With the other nuclides most of the applied model fallout remained at the soil surface. Usually humus loamy soil and silty clay soil showed the strongest retention for the fission products investigated, whereas sandy soils showed the least retention. It is emphasized that results of such mock-up experiments can be extrapolated to field conditions only with reservations. In agreement with literature data, however, the described studies did not indicate that in the field the dose rate above a contaminated soil will decrease, due to displacement of fallout to depths of the soil, within a short period of time. (BBB)

36120 MEASUREMENT OF SOIL MOISTURE IN THE FIELD BY NEUTRON MODERATION. Long, I. F.; French, B. K. (Rothamsted Experimental Station, Harpenden, Eng.). J. Soil Sci., 18: 149-66(Mar. 1967).

Design, calibration, working hazards and precautions, and field use of a soil-moisture meter are described. The probe carries a source (^{241}Am-Be) and a detector ($^{10}BF_3$) in an Al case. Source and detector are as close to each other as possible, giving a desired linear relation between thermal neutron count and the volumetric water content around the probe. The portable scaler incorporates some new features of circuit design that lead to ease of operation and small size; it weighs 5 Kg. Factors involved in calibration or the interpretation of a calibration curve are: resolving time of the scaler, the volume of soil explored by the neutrons, the effect of a moisture gradient, and the possible effect of elements other than H. Field trials were conducted in 2 groups. In 1962 and 1963 frequent measurements were made in bare clay soil and under a nearby barley crop: from the profiles, the extraction of water from the bare soil was limited to the top 30 cm, but the barley roots took water out at least as deeply as the maximum depth of measurement then possible, 90 cm. In 1964 similar measurements under first-year timothy and meadow fescue, irrigated and nonirrigated, showed that the total water abstracted by each was nearly the same, but the timothy took most of its water from the top 40 cm of profile, whereas the fescue took more water from the lower depths. Combining the estimated deficits with known rainfall gave values of periodic evaporation in good agreement with aerodynamic estimates based on temperature, humidity, and wind profiles above the crop, and in fair agreement with potential evaporation-rates calculated from routine weather records. (BBB)

36121 RADIOACTIVITY OF ALLANITE CRYSTALS FROM A ROCK IN THE GERES MOUNTAIN. de Morais, Marilia Xavier Publ. Museu Lab. Mineral. Geol. Univ. Coimbra Centro Estud. Geol., Mem. Notic., No. 55, 95-104(1963). (In Portuguese).

Grandiorite rock, with a large quantity of allanite crystals of many variable dimensions ranging from very small inclusions in mica to visible crystals, was studied by the nuclear emulsion method. Among the crystals studied some contain uranium only and others contain uranium and a smaller or larger percentage of thorium. It was found that in some well developed and zoned allanite crystals the radioactive matter is concentrated in the more external layers. (auth)

36122 RADIOACTIVITY OF GRANITE MINERALS OF PARDELHAS (FAFE). de Morais, Marilia Xavier. Publ. Museu Lab. Mineral. Geol. Univ. Coimbra Centro Estud. Geol., Mem. Notic., No. 56, 57-61(1963). (In Portuguese).

The crystals of the radioactive minerals present in a granitic rock from Pardelhas and in a granodiorite encrave has been studied by sensitive alpha nuclear emulsions. It was found that the average radioactivity of the minerals is lower in crystals of the granite than that in the crystals of the granodiorite encrave. (auth)

36123 RADIOACTIVITY OF SPHENE CRYSTALS FROM SOME ROCKS. de Morais, Marilia Xavier. Publ. Museu Lab. Minell. Geol. Univ. Coimbra Centro Estud. Geol., Mem. Notic., No. 57, 43-54(1964). (In Potuguese).

Some results of the determination, by the nuclear emulsion method, of the radioactivity of the crystals of sphene in some crystalline rocks are given. It is shown that average radioactivity of those crystals increases with the increase in the silica percentage in the rock. The radioactivity of the sphenes also suggests that there is an increase in the concentration of radioactive elements for the smaller crystals. A monazite from the Foz-do-Douro (Porto) does not verify any of these laws. (auth)

36124 DISTRIBUTION OF THE RADIOACTIVE ELEMENTS IN A ROCK FROM VILA PERY (MOZAMBIQUE). de Morais, Marilia Xavier. Publ. Museu Lab. Mineral. Geol. Univ. Coimbra Centro Estud. Geol., Mem. Notic., No. 60, 59-64(1965). (In Portuguese).

The distribution of the radioactivity in a migmatite from Vila Pery (Mozambique) has been studied by nuclear emulsion method. It has been determined that the bulk of the radioactivity is due mainly to the presence of accessory minerals, allanite, sphene and zircon and secondary joint-filling minerals. (auth)

36125 MEASUREMENT OF THE RELATIVE ABUNDANCE OF XENON ISOTOPES USING AN ELECTRIC MASS FILTER. Bruchhausen, K.; Gebauer, S.; von Zahn, U. (Univ., Bonn). Z. Naturforsch., 22a: 969-72(June 1967). (In German).

The relative abundances of the isotopes of terrestrial xenon were re-determined using a large quadrupole spectrometer. All 11 measured isotopic ratios were in good agreement with the 1950 results of Nier (Nier, A. O., Phys. Rev. 79, 450(1950)). However, within the error limits a small, but systematic enrichment of the lighter isotopes was noticed in the data as compared to Nier's. (auth)

36126 ISOTOPE TECHNIQUES IN THE HYDROLOGIC CYCLE. Papers Presented at a Symposium at the University of Illinois, November 10–12, 1965. Stout, Glenn E. (ed.). Geophysical Monograph Series, Number 11. Washington, D. C., American Geophysical Union, 1967. 205p. (CONF-651108).

A total of 28 papers were presented at the Symposium. Six of the papers were previously abstracted in NSA. Separate abstracts were prepared for the remaining 22 papers. (J.R.D.)

For abstracts of individual papers see: 36127–36142 and 36153–36158.

36127 DEVELOPMENT OF A RADIOISOTOPE GAGE FOR MONITORING SEDIMENT CONCENTRATION IN RIVERS AND STREAMS. Sellers, Bach; Ziegler, Charles A.; Papadopoulos, John (Parametrics, Inc., Waltham, Mass.). pp 3-10 of Isotope Techniques in the Hydrologic Cycle. Stout, Glenn E. (ed.). Washington, D. C., American Geophysical Union, 1967.

From Symposium on Isotope Techniques, Urbana, Ill., Nov. 10–12, 1965. See CONF-651108.

A radioisotope gage has been developed that is capable of determining the concentration of suspended sediment in rivers and streams. The gage measures transmission of 22-keV x rays from ^{109}Cd through the sediment-containing water and compares the results with the transmission through a distilled water sample. Unattended operation over a period of 7½ days is possible, and accuracy is better than ±20% for all sediment concentrations in the range 1,000 to 50,000 ppM. The unit has been calibrated and field tested and is presently being delivered for extended evaluation on site. (auth)

36128 ISOTOPE SNOW GAGES FOR DETERMINING HYDROLOGIC CHARACTERISTICS OF SNOWPACKS. Smith, James L.; Willen, Donald W.; Owens, Michael S. (Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif.). pp 11-21 of Isotope Techniques in the Hydrologic Cycle. Stout, Glenn E. (ed.). Washington, D. C., American Geophysical Union, 1967.

From Symposium on Isotope Techniques, Urbana, Ill., Nov. 10–12, 1965. See CONF-651108.

Gammas from a source in one access tube pulse through the snowpack to another tube and are detected with a crystal-photomultiplier assembly, channeled through a single-window discriminator set to pass only gammas in the photo-peak energy level. From here the pulse is sent to a ratemeter-scaler. With this system, snow density may be measured accurately in ½-inch vertical increments. For faster operation, a special Geiger–Mueller detector can be used to profile snowpacks in 2-inch vertical increments. The instrument is shown to be superior to any system heretofore used for detection of snow depth, water content, and density. (auth)

36129 DOWNWARD MOVEMENT OF SOIL MOISTURE TRACED BY MEANS OF HYDROGEN ISOTOPES. Zimmermann, U.; Muennich, K. O.; Roether, W. (Univ., Heidelberg). pp 28-36 of Isotope Techniques in the Hydrologic Cycle. Stout, Glenn E. (ed.). Washington, D. C., American Geophysical Union, 1967.

From Symposium on Isotope Techniques, Urbana, Ill., Nov. 10–12, 1965. See CONF-651108.

The measurements reported show that movement of soil moisture is layered. A single rainfall, artificially spiked with isotope tracer, will therefore form a tagged layer of water, which, although blurred by diffusion effects, moves downward as a distinguishable boundary between the older rainwater below and the younger rainwater above. After a certain time and a corresponding displacement of the tracer peak, a balance can be drawn between incoming rain (corrected for runoff) during the period in question and the water still remaining in the soil and eventually yielding groundwater, the difference being the evaporation loss. Fine grain soils show average draining velocities below 1 meter per year, so that the method gives accurate values only for periods of at least a few months. The theoretical basis and the limitations of the method are discussed. The method should provide detailed information on the water balance without disturbing the natural conditions and should be applicable everywhere at low cost. (auth)

36130 CONTRIBUTION OF ISOTOPE TECHNIQUES TO THE STUDY OF SOME HYDROLOGICAL PROBLEMS. Payne, Bryan R. (International Atomic Energy Agency, Vienna). pp 62-8 of Isotope Techniques in the Hydrologic Cycle. Stout, Glenn E. (ed.). Washington, D. C., American Geophysical Union, 1967.

From Symposium on Isotope Techniques, Urbana, Ill., Nov. 10–12, 1965. See CONF-651108.

The occurrence of environmental tritium and the variations in concentration of deuterium and ^{18}O have been applied to the solution of some hydrological problems. Examples are given of field studies in which information has been obtained on the turnover time of lakes, the interconnections between different water bodies, the location of recharge areas, and the transit times since recharge. The results are discussed in relation to the hydrology of the areas. (auth)

36131 APPLICATION OF DEUTERIUM ANALYSES TO THE HYDROLOGY OF THE LAKES OF THE GRAND COULEE, WASHINGTON. Friedman, Irving (Geological Survey, Denver); Redfield, Alfred C. pp 77-80 of Isotope Techniques in the Hydrologic Cycle. Stout, Glenn E. (ed.). Washington, D. C., American Geophysical Union, 1967.

From Symposium on Isotope Techniques, Urbana, Ill., Nov. 10–12, 1965. See CONF-651108.

Results of an investigation concerned with the hydrology of a series of lakes that occupy the abandoned gorge of the Columbia in Grant County, eastern Washington, are presented. The utility of deuterium determinations in hydrologic studies is examined. The heavy isotopic forms of water, HDO and $H_2{}^{18}O$, occur in natural waters in variable concentrations which are readily measurable. Consequently they can serve as natural tracers. Changes in the deuterium content of natural waters ordinarily take place only when the water undergoes a change in phase as by freezing or evaporation, and it may be assumed that while underground the deuterium concentration is a conservative property. It may be expected that, when used in conjunction with the ionic composition, deuterium data may serve to identify the probable sources of water pumped from the ground and to estimate the proportions in which such components are present. When surface waters undergo evaporation the change in concentration of deuterium follows different laws than does the change in ionic content. This permits simultaneous equations for the balance of water, deuterium, and salt to be used to estimate the character and quantity of the inflow and outflow from natural reservoirs. An analysis of results shows that the upper lakes, Park and Blue, receive over 90% of their water from upstream surface inflow. Lenore Lake receives a major part of its water from upstream subsurface seepage, plus a sizeable contribution of West Canal leakage. Soap Lake is fed mainly by West Canal leakage, plus a little seepage from Lenore. The analysis also accounts for the changes in salinity experienced by the lakes and can be used to predict future salinity changes. (J.R.D.)

36132 ULTRA-LOW-VELOCITY MEASUREMENT IN A STRATIFIED RESERVOIR BY ISOTOPIC CURRENT METER. Elder, Rex A.; Vigander, Svein (TVA Engineering Lab., Norris, Tenn.). pp 81-4 of Isotope Techniques in the Hydrologic Cycle. Stout, Glenn E. (ed.). Washington, D. C., American Geophysical Union, 1967.

From Symposium on Isotope Techniques, Urbana, Ill., Nov. 10–12, 1965. See CONF-651108.

Field measurements of the velocities that occur in TVA's Fontana Reservoir are described. Thermal density stratification of a uniformly varying type occurs in this reservoir and results in the withdrawal occurring from a discrete layer rather than through the full depth. The velocities, which are in the neighbor of from 0 to 0.10 ft/sec, will be measured by means of an instrument that uses radioactive iodine as a tracer. This meter is termed DWICA-1, for Deep Water Isotopic Current Analyzer. The instrument will also measure the current direction. (auth)

36133 WATER TRACING IN THE HYDROLOGIC CYCLE. Thatcher, L. L. (International Atomic Energy Agency, Vienna). pp 97-108 of Isotope Techniques in the Hydrologic Cycle. Stout, Glenn E. (ed.). Washington, D. C., American Geophysical Union, 1967.

From Symposium on Isotope Techniques, Urbana, Ill., Nov. 10–12, 1965. See CONF-651108.

The use of tritium, deuterium, oxygen-18, and carbon-14 to represent circulation on the continental and hemispheric scale gives new significance to the tracing of water movement through the hydrologic cycle. The traditional concept of tracers as limited tools to obtain data about micro-areas within extensive aquifers (analogous to measuring permeability on core samples to obtain the permeability of an aquifer) is outdated by the newer techniques. The tracers of interest for investigation of the hydrologic cycle are introduced on the grand scale by natural processes and fallout, and the data obtained by observing their distributions represent integrations of transport processes over large areas. Radioisotopes have also contributed to the investigation of the local or micro-aspects of the hydrologic cycle. Radioisotope tracers have been substituted for chemical tracers in groundwater velocity and direction measurements, the investigation of stratified flow, directional information from pumping tests, and similar studies. (auth)

36134 RADIOCARBON DETERMINATIONS APPLIED TO GROUNDWATER HYDROLOGY. Hanshaw, Bruce B. (Geological Survey, Washington, D. C.); Rubin, Meyer; Back, William; Friedman, Irving. pp 117-18 of Isotope Techniques in the Hydrologic Cycle. Stout, Glenn E. (ed.). Washington, D. C., American Geophysical Union, 1967.

From Symposium on Isotope Techniques, Urbana, Ill., Nov. 10–12, 1965. See CONF-651108.

Problems associated with the use of radiocarbon determinations in hydrology are discussed. Corrections for potential sources of error can be effected by the use of stable isotopes and by field determination of pH and alkalinity. Results of studies on aquifers indicate that the use of radiocarbon in hydrology and geochemistry constitutes advanced technology. (J.R.D.)

36135 GROUNDWATER FLOW AND DIRECTION MEASUREMENT BY MEANS OF RADIOISOTOPES IN A SINGLE WELL. Mairhofer, J. (Bundesversuchs- und Forschungsanstalt Arsenal, Vienna). pp 119-29 of Isotope Techniques in the Hydrologic Cycle. Stout, Glenn E. (ed.). Washington, D. C., American Geophysical Union, 1967.

From Symposium on Isotope Techniques, Urbana, Ill., Nov. 10–12, 1965. See CONF-651108.

Results from laboratory and field experiments are given to demonstrate the usefulness of the point dilution method of velocity measurement. Data from experiments are used to characterize the input of water in a horizontal pumping station. A probe is used to estimate the permeability of an aquifer before and after concrete injections in a permeable river bank. Radioisotope measurements of flow direction by means of the single well technique were used. The chemical form of the injected tracer for flow direction measurements in different geological formations must be taken into account. (J.R.D.)

36136 USE OF CHEMICAL AND RADIOACTIVE TRACERS AT THE NATIONAL REACTOR TESTING STATION, IDAHO. Morris, Donald A. (National Reactor Testing Station, Idaho Falls, Idaho). pp 130-42 of Isotope Techniques in the Hydrologic Cycle. Stout, Glenn E. (ed.). Washington, D. C., American Geophysical Union, 1967.

From Symposium on Isotope Techniques, Urbana, Ill., Nov. 10–12, 1965. See CONF-651108.

Chemical and radioactive tracers were used in studies of the geology and the hydrology of the basalt terrane at the National Reactor Testing Station. A salt tracer, used near waste disposal from the Idaho Chemical Processing Plant, indicated rates of flow ranging from 15 to 50 ft/day in the regional groundwater reservoir, and a sodium fluorescein dye indicated an average rate of flow of about 23 ft/day. Recent studies using tritium indicated average rates of flow of about 54 ft/day based on first arrival and from 10 to 13 ft/day based on the arrival of the center of mass or maximum tritium concentration. Studies of the water perched in the alluvium and basalt underlying the Test Reactor Area indicated a rate of flow of about 2 to 10 ft/day. Long-range tritium studies in the regional groundwater reservoir in the Central Facilities Area indicated rates of flow of 6 to 8 ft/day under normal hydraulic gradients of 5 ft/mile at distances of 4 to 5 miles from points of injection. (auth)

36137 RADIOCARBON AGES OF GROUNDWATER IN AN ARID ZONE UNCONFINED AQUIFER. Tamers, M. A. (Instituto Venezolano de Investigaciones Cientificas, Caracas). pp 143-52 of Isotope Techniques in the Hydrologic Cycle. Stout, Glenn E. (ed.). Washington, D. C., American Geophysical Union, 1967.

From Symposium on Isotope Techniques, Urbana, Ill., Nov. 10–12, 1965. See CONF-651108.

The water-dissolved carbon dioxide and bicarbonate are extracted and used as material for radiocarbon dating. The groundwater deposit of the city of Maracaibo has been studied as a typical arid zone unconfined aquifer. It was found that the system is no longer being recharged, and that the water dates from the pluvial conditions prevailing at the end of the last glacial period. The effect of the dilution of the original carbon by dissolved limestone is discussed, and conclusions are drawn as to the extent of the errors involved in corrections for this factor. Practical considerations of the study are illustrated. (auth)

36138 LARGE-SCALE UTILIZATION OF TRITIUM IN HYDROLOGIC STUDIES. Eriksson, Erik (International Meteorological Inst., Stockholm). pp 153-6 of Isotope Techniques in the Hydrologic Cycle. Stout, Glenn E. (ed.). Washington, D. C., American Geophysical Union, 1967.

From Symposium on Isotope Techniques, Urbana, Ill., Nov. 10–12, 1965. See CONF-651108.

Tritium is an excellent tracer for circulation of water in nature in many of its phases and will be indispensable as a research tool during the Hydrologic Decade. The currently available data make it possible to study some large-scale phenomena like rate of exchange of water across the sea surface and rate of the exchange between sea surface water and deeper sea water. The hydrologic characteristics of river basins can also be studied, as well as similar characteristics of groundwater reservoirs. In these cases the characteristics, suitably defined, are revealed by the distortion of the tritium pulses in precipitation, which occur when water is passing through the reservoirs. For full utilization of large-scale tritium as a tracer in hydrologic studies, it is necessary to collect data over many future years. (auth)

36139 FRACTIONATION OF TRITIUM AND DEUTERIUM IN SOIL WATER. Stewart, Gordon L. (Geological Survey, Washington, D. C.). pp 159-68 of Isotope Techniques in the Hydrologic Cycle. Stout, Glenn E. (ed.). Washington, D. C., American Geophysical Union, 1967.

From Symposium on Isotope Techniques, Urbana, Ill., Nov. 10–12, 1965. See CONF-651108.

Laboratory investigations are being conducted to determine the potential capabilities of hydrogen isotopes in age-dating techniques and as tracers for ground and surface waters. Preliminary results show that tritium and deuterium interact with clay minerals as water diffuses through Davidson clay. The data suggest that two stages characterize this interaction with clay minerals: a rapid exchange with more labile hydroxyl groups, followed by exchange with other structural hydroxyls. The initial and rapid exchange was characteristic, but to varying degrees, of all clay minerals used in this investigation. Except for tritium in Davidson clay, the data were not sufficient to show that additional exchange occurs beyond the first stage. The data suggest that isotopic exchange and fractionation of hydrogen isotopes in the clay-water system may be significant for some age-dating and water-tracing investigations where water flow is slow through some kinds of clays. For many investigations, however, this isotope effect is not important, because it is small compared with accuracies required of the data. As the tracer art progresses, it will become possible to apply isotope effect corrections to the data. (auth)

36140 TECHNIQUES OF GROUNDWATER TRACING USING RADIONUCLIDES. Merritt, W. F. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 169-70 of Isotope Techniques in the Hydrologic Cycle. Stout, Glenn E. (ed.). Washington, D. C., American Geophysical Union, 1967.

From Symposium on Isotope Techniques, Urbana, Ill., Nov. 10–12, 1965. See CONF-651108.

The properties of commonly used radionuclides for tracing ground water are discussed. Comparisons are made of their movement through the soil, half-lives, permissible levels, price, ease of handling, and measurement. Counting methods are also compared in terms of sensitivity and cost. (J.R.D.)

36141 THE USE OF A TRACER TEST TO VERIFY AN ESTIMATE OF THE GROUNDWATER VELOCITY IN FRACTURED CRYSTALLINE ROCK AT THE SAVANNAH RIVER PLANT NEAR AIKEN, SOUTH CAROLINA. Marine, I. Wendell (Geological Survey, Aiken, S. C.). pp 171-9 of Isotope Techniques in the Hydrologic Cycle. Stout, Glenn E. (ed.). Washington, D. C., American Geophysical Union, 1967.

From Symposium on Isotope Techniques, Urbana, Ill., Nov. 10–12, 1965. See CONF-651108.

Results of an investigation at the Savannah River plant indicated the feasibility of and the safety afforded by the storage of high-level radioactive wastes in unlined chambers excavated in crystalline rock about 1500 feet beneath the ground surface. The crystalline rock, consisting of schist and gneiss, is overlain by approximately 1000 feet of unconsolidated sediments. Water in the fractures in the crystalline rock is separated from water in the overlying sediments by a virtually impermeable layer of saprolite clay. Of considerable importance to this waste containment concept are the rate and direction of water movement through fractures in the crystalline rock. It was found that most of the rock was virtually impermeable and included only very minute fractures. However, some sections had more open fractures through which water could be transmitted at a faster rate. Initial estimates of the groundwater velocity in the rock were made, using hydraulic parameters estimated from data obtained from observation wells and from pumping and swabbing tests. The analysis used in estimating these data assumed that fractures in both types of rock were sufficiently numerous that each approximated a homogeneous medium. Estimates of the natural groundwater velocity were 0.5 ft/yr in virtually impermeable rock and 5.4 ft/yr for zones of more open fractures. To test the validity of these hydraulic estimates, a between-holes tracer test using tritium was designed and is now in progress. Water is pumped from one rock well and piped to another well 1760 feet away where it is injected. In August 1964, 300 curies of tritium were injected into the system during a 29-hour period. The tritium was first detected 73 days after its injection, and since then the tritium concentration in the pumped well has increased slowly but steadily. The shape of the arrival curve lends support to the assumption that the fractured sections consist of numerous interlacing fractures. It appears that the peak concentration of tritium was reached in about one year, making the average groundwater velocity 1760 ft/yr. The predicted average velocity for the tracer test based on the estimated gradient and permeability and an assumed porosity was 320 ft/yr, making this estimate too low by a factor of 5.5. (auth)

36142 GENERAL COMMENT ON MICROBIOLOGICAL ACTIVITY AND ITS EFFECTS ON ISOTOPIC STUDIES OF WATER. Krouse, H. R. (Univ. of Alberta, Edmonton). pp 195 of Isotope Techniques in the Hydrologic Cycle. Stout, Glenn E. (ed.). Washington, D. C., American Geophysical Union, 1967.

From Symposium on Isotope Techniques, Urbana, Ill., Nov. 10–12, 1965. See CONF-651108.

Comments are presented concerning microbiological conversions and their effects on carbon-12/-13 and sulfur-32/-34 variations in hydrologic cycles of the hot and cold springs of the Banff and Jasper areas of Canada. Investigation results indicate that water sample storage for lengthy periods before separation and analysis is undesirable. (J.R.D.)

36143 GEOFIZICHESKAYA APPARATURA. VYPUSK 29. (Geophysical Apparatuses. Volume 29). Vikulin, B. K. (ed.). Leningrad, Izdatel'stvo Nedra, 1966. 215p.

Design and performance of magnetic seismographic, radiometric, and computing devices used in geophysical prospecting are described. Nuclear magnetometers, x-radiometers, neutron activation and photonuclear analyzers are discussed. The performance of high voltage sinusoidal transformers for field neutron generators, radiofrequency cables, and transistorized x-ray spectral tubes and computers are also discussed. (R.V.J.)

Meteorology

Refer also to abstracts 36188, 36273, 36315, 36316, 36328, 38637, and 38828.

36144 (AWRE-O-43/59) SCAVENGING ACTION OF RAIN ON NON-WETTABLE PARTICULATE MATTER SUSPENDED IN THE ATMOSPHERE. Pemberton, C. S. (Atomic Weapons Research Establishment, Aldermaston (England)). [nd]. 34p. Dep.

A mechanism of capture of a non-wettable particle by a liquid drop, in which capture is opposed by the surface tension of the drop, was investigated and a non-dimensional number called the penetration factor was derived together with a condition for the retention of the particle by the drop. The equations of motion of a particle moving under Stokes' law of resistance in the velocity field due to potential flow around a sphere are integrated numerically. The collection efficiencies so obtained are shown to depend not only on the inertia parameter, as demonstrated by previous work on wettable particles and droplets, but upon the penetration factor, and a non-dimensional form of the retention condition. Together with drop size distributions obtained experimentally, and the application of a statistical procedure, the new results are used to determine the fraction of particles of a given size removed by rainfalls of several intensities and durations, and a nomograph is constructed. Finally, an application is made to determine the total amount of radioactivity rained-out from an atomic cloud having an empirical particle-size distribution. The effectiveness of the scavenging action of rain is shown to depend critically on the assumed activity-particle size distribution, and is considerably reduced for non-wettable particles. (auth)

36145 (GAT-552) ENVIRONMENTAL RADIATION LEVELS AND CONCENTRATIONS FIRST HALF 1967. Hulett, S. H. (Goodyear Atomic Corp., Piketon, Ohio). July 20, 1967. Contract AT(33-2)-1. 10p. Dep. CFSTI.

The average environmental radiation and concentration levels for the Goodyear Atomic Corporation gaseous diffusion plant, for the first half of 1967 and for the calendar year 1966, are summarized. For the first half of 1967 the water alpha, airborne alpha and beta-gamma, and the background dose rate remained substantially unchanged compared with the 1966 results. The water beta-gamma, however, increased for the first half of 1967. This increase was caused by one sample obtained from a plant effluent stream inside the plant boundaries (the results showed only 6.0% of the AEC concentration standards). Samples taken downstream of all plant effluent showed a dilution factor of 17 to 1. Penetrating background dose rates remained unchanged from the 1966 values. In the calculations all of the exposure rates were assumed attributable to plant operations. As in the past, however, the off-site and on-site patterns are very much alike in form and intensity with no significant differences between the average values. Based on the on-site and off-site intensities and the continuing decline in exposure rates which follows the cessation of nuclear testing activities, it is evident that the plant operations have not added appreciably to the general background penetrating radiation. (auth)

36146 (IAEA-3162-1) THE MEASUREMENT OF HYDROGEN AND OXYGEN ISOTOPES IN NATURAL WATERS AND ITS APPLICATION TO METEOROLOGY AND HYDROLOGY. Final Report. Payne, B. R.; Thatcher, L. L.; Cameron, J. F.; Florkowski, T. (International Atomic Energy Agency, Vienna (Austria)). May 1967. Contract AT(30-1)-3162. 119p. Dep. CFSTI.

An analytical system is described for the routine concentration and measurement of the maximum number of tritium samples with concentrations greater than 0.5 T.U. Tritium deposition is estimated for use in the determination of the amount of tritium transferred from the stratosphere to the troposphere to provide insight into fallout behavior, and in investigating water vapor equilibrium between troposphere and stratosphere, and to predict future tritium fallout. Data are presented for determination of tritium deposition between 1962 and 1965. Tritium inventory in the stratosphere at the end of 1962 was ~170 kg. It was estimated that ~30 kg was still in the stratosphere at the end of 1965. The method of determining the average tritium concentration using ^{90}Sr fallout is discussed. (F.S.)

36147 (NP-16800) RADIOACTIVITY SURVEY DATA IN JAPAN, NUMBER 13. (National Inst. of Radiological Sciences, Chiba (Japan)). Nov. 1966. 20p. Dep.

Vegetables were analyzed for ^{90}Sr and ^{137}Cs content at 22 locations in Japan. Total diet samples from 19 prefectures were analyzed for ^{137}Cs and ^{90}Sr content. Investigations of blood samples were used to determine total body burden of ^{137}Cs. Gross β and radioiodine in rain and dry fallout from the Fourth Chinese nuclear test, the fallout ratio of uranium-237 to neptunium-239, and the gross radioactivity in the upper air were determined. Zirconium-95, ^{95}Nb, ^{106}Ru, ^{106}Rh and ^{144}Ce in airborne dusts were identified by γ-ray spectroscopy. (F.S.)

36148 (NP-16801) ANNUAL SUMMARY ON ENVIRONMENTAL RADIOACTIVITY IN NEW ZEALAND AND RESULTS OF EXTENDED MONITORING OF FALLOUT FROM FRENCH NUCLEAR TESTS IN THE PACIFIC. Quarterly Report, October-December 1966. (National Radiation Lab., Christchurch (New Zealand)). 69p. (NRL-F-23). Dep.

In monitoring environmental contamination in New Zealand in 1966, a distinction was made between the levels of radioactivity due to long-lived radionuclides, which are significant in assessing health hazards, and short-lived radionuclides from the French Nuclear Tests. Levels of long-lived ^{90}Sr and ^{137}Cs in rainwater and milk decreased. Strontium-89 from the French tests was measured in milk and rainwater. The low value of the ratio of strontium-89 to -90 indicated that most of the ^{90}Sr came from the stratospheric reservoir of ^{90}Sr from previous tests. The strontium-90 level in rainwater was less than $\frac{1}{2}$ of the 1966 value and ^{90}Sr in milk was reduced to $\frac{2}{3}$ of the average level for 1965. Fallout levels in air and rainwater due to short-bomb debris increased 10 fold during the fourth quarter. No γ-ray radiation exceeding 0.3 m R/hr was reported from any of the 7 Pacific Island Stations. Age estimation of fission products present in selected air filters showing high total β activity was made. An increase in total β activity was detected at all stations. The level of ^{131}I in milk increased over all of New Zealand with the highest 36 pCi/l in October with levels falling in December. Iodine-131 was detected in thyroids at all stations with the highest level of 726 pCi/g found in October. The ^{90}Sr level for the year was ~6% of the cautionary level or ~3% of the permissible level. Less than 0.6% of the permissible level of ^{137}Cs was found. Total β activity in the air was ~1.5% and ^{131}I level was less than 2% of the acceptable level. (F.S.)

36149 (SC-CR-67-2530) COMPUTER PROGRAM FOR THE FALL AND DISPERSION OF PARTICLES IN THE ATMOSPHERE. Hage, K. D.; Brown, P. S.; Arnason, G.; Lazorick, S.; Levitz, M. (Travelers Research Center, Inc., Hartford, Conn.). Apr. 1967. Contract 48-4932. 214p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

A computer program was formulated for calculating air concentrations and ground deposits of solid particles of various densities and intermediate diameters (about 3 to 300 microns, density 10) released from instantaneous point or line sources at altitudes up to 90 km. The program was developed for use in aerospace nuclear safety hazards analyses. Complete program specifications, descriptions, and operating instructions are given along with some operating guidelines and aids. Examples of input and output are discussed and illustrated. (auth)

36150 (AEC-tr-6711) RADIOACTIVE ISOTOPES IN THE ATMOSPHERE AND THEIR USE IN METEOROLOGY. Conference on Nuclear Meteorology, Obninsk, 3-6 February 1964. Karol', I. L.; Kirichenko, L. V.; Krasnopevtsev, Yu. V.; Kurganskaya, V. M.; Malakhov, S. G.; Sereda, G. A.; Yagodovskii, I. V. (eds.). Translation of Radioaktiv. Izotopy Atmos. Ispol'z. Meteorol., Nauch. Konf. Yad. Meteorol., Obninsk, 3-6 February 1964, 1-491 (1965). 374p. (IPST-Cat.-1801; CONF-640208). CFSTI.

A total of 45 papers were presented at the conference. These papers were abstracted in NSA Vol. 20 issue 10. (J.R.D.)

36151 LOW-PRESSURE CASCADE IMPACTOR AS A TOOL FOR THE STUDY OF SIZE DISTRIBUTION OF FISSION-PRODUCT AEROSOLS. Parker, G. W. (Oak Ridge National Lab., Tenn.); Buchholz, H. Trans. Amer. Nucl. Soc., 10: 338-9(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36152 COSMIC-RAY-PRODUCED RADIONUCLIDES AS TRACERS OF ATMOSPHERIC PRECIPITATION PROCESSES. Wogman, N. A.; Thomas, C. W.; Cooper, J. A.; Engelmann, R. J.; Perkins, R. W. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 22(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36153 APPLICATION OF ISOTOPES TO SOME PROBLEMS IN ATMOSPHERIC SCIENCES. Bierly, Eugene W. (Atomic Energy Commission, Washington, D. C.). pp 37-46 of Isotope Techniques in the Hydrologic Cycle. Stout, Glenn E. (ed.). Washington, D. C., American Geophysical Union, 1967.

From Symposium on Isotope Techniques, Urbana, Ill., Nov. 10-12, 1965. See CONF-651108.

The best known application of isotopes in the field of atmospheric sciences has been the tracing of air motions on a global scale through the sampling of nuclear debris by high-altitude balloons and aircraft. This application as well as other successful ones will be discussed briefly as a review. The emphasis in this paper will

be on the use of isotopes as tracers of atmospheric motions in problems of cloud physics. By discussing details of some specific problems more meteorologists may recognize the value of isotopic tracing in their research work. Such a tool can be a great aid in understanding better the motions of the air on all scales. (auth)

36154 BALLOON-BORNE HYGROMETER SYSTEM FOR THE MEASUREMENT OF ATMOSPHERIC WATER VAPOR. Rohrbough, Stephen F.; Ballinger, John G.; Koehler, Lyle E. (Honeywell, Inc., St. Paul). pp 47-54 of Isotope Techniques in the Hydrologic Cycle. Stout, Glenn E. (ed.). Washington, D. C., American Geophysical Union, 1967.

From Symposium on Isotope Techniques, Urbana, Ill., Nov. 10–12, 1965. See CONF-651108.

A balloon-borne system for determining the atmospheric water-vapor content through the use of an alpha-radiation detection technique is described. Precautions have been taken to reduce the amount of water vapor from extraneous sources such as the command system, batteries, and parachute. Results from several flights with this system are reported. (auth)

36155 DIFFUSIOPHORETIC AND THERMOPHORETIC EFFECTS ON PARTICULATE MATTER NEAR CONDENSING AND EVAPORATING WATER SURFACES. Goldsmith, Phillip (Atomic Energy Research Establishment, Harwell, Eng.). pp 55 of Isotope Techniques in the Hydrologic Cycle. Stout, Glenn E. (ed.). Washington, D. C., American Geophysical Union, 1967.

From Symposium on Isotope Techniques, Urbana, Ill., Nov. 10–12, 1965. See CONF-651108.

Radioactive tracer techniques have been used to study the velocity induced on submicron aerosol particles by diffusing water vapor. Similar experiments have also been made on their velocity in temperature gradients. Often in nature, diffusing water vapor is associated with a temperature gradient in the carrier gas, for instance near a cool surface on which water is condensing. Further measurements have been carried out on the superimposed diffusiophoretic and thermophoretic velocities. The role of these mechanisms in the scavenging of particulate matter from the atmosphere is discussed in the light of these experiments. (auth)

36156 ATMOSPHERIC TRANSPORT OF TRITIUM. Eriksson, Erik (International Meteorological Inst., Stockholm). pp 56-7 of Isotope Techniques in the Hydrologic Cycle. Stout, Glenn E. (ed.). Washington, D. C., American Geophysical Union, 1967.

From Symposium on Isotope Techniques, Urbana, Ill., Nov. 10–12, 1965. See CONF-651108.

It is noted that although tritium appears in water as HTO, its circulation in nature differs from that of water. An analysis of the reasons for these differences is presented. (J.R.D.)

36157 HURRICANE TRITIUM. I. PRELIMINARY RESULTS ON HILDA 1964 AND BETSY 1965. Oestlund, H. Goete (Univ. of Miami, Fla.). pp 58-60 of Isotope Techniques in the Hydrologic Cycle. Stout, Glenn E. (ed.). Washington, D. C., American Geophysical Union, 1967.

From Symposium on Isotope Techniques, Urbana, Ill., Nov. 10–12, 1965. See CONF-651108.

The tritium concentration in water vapor of undisturbed tropical air is roughly 10 times higher than that of surface sea water. When this air is entrained into a hurricane, the extent of air-sea exchange of water is quantitatively reflected in the lowering of the tritium concentration of the air approaching the eye. (auth)

36158 TRACING OF RADIOISOTOPES RELEASED INTO THE LOWER TROPOSPHERE. Warburton, Joseph A. (Univ. of Nevada, Reno). pp 61 of Isotope Techniques in the Hydrologic Cycle. Stout, Glenn E. (ed.). Washington, D. C., American Geophysical Union, 1967.

From Symposium on Isotope Techniques, Urbana, Ill., Nov. 10–12, 1965. See CONF-651108.

A description is given of the instrumentation used in airborne tracing measurements of the dispersion of radioisotopes released in clear air and in clouds in Australia. Ten separate releases of radioisotopes have been made, using 100-mc quantities of ^{133}Xe and up to 2-curie quantities of ^{64}CuO. The overall purpose of the experiment was to develop a technique that would enable cloud physicists to determine the efficiency with which cloud-seeding agents were swept into the supercooled portions of a convective cloud after release at the base of the cloud (the usual seeding method in convective conditions). The γ-emitting radioisotopes released were traced for periods up to 45 minutes, and indications were that it would be possible to handle and release 20-curie quantities. On this basis the upper limit of volume throughout which measurements of radioisotope concentration can be made is at least 4 cubic miles. The presentations also included a brief description of the use of the same instrumentation for making observations of the naturally occurring radioactivity in the atmosphere. This activity constituted the background against which the artificially released activity was measured. (J.R.D.)

36159 OBSERVATIONAL EVIDENCE ON TRANSPORT OF RADIOACTIVITY AND OZONE THROUGH THE TROPOPAUSE. Murayama, Nobuhiko (Japan Meteorological Agency, Tokyo). Geophys. Mag. (Tokyo), 33: 149-62 (Nov. 1966).

On March 27, 1961, more than 2 yr after cessation of the nuclear tests in 1958, extraordinarily high radioactivity was recorded by a γ-activity sonde launched at Tateno (36°N), in the layer between about 500 and 300 mb levels in the region of strong upper fronts extruded down from the tropopause. This is discussed in terms of an instance of the radioactive dusts originating in the stratosphere being transferred into the troposphere through the tropopause break by disturbances developed in the upper troposphere. Extremely high tritium concentration (23,200 TU) in the rains from Mar. 26 to Apr. 3, 1962 in Tokyo was attributable to a similar upper tropospheric situation. Both cases were characterized by steepened isentropic lines along the 140°E meridian in the upper troposphere. A similar example as reported by Kroening et al. in vertical ozone distribution (45°N) on July 7, 1961 was compared with the present findings. These results agreed with Danielsen's finding that a high radioactivity layer appeared in the upper troposphere associated with tropopause folding. Seasonal variation of the long-lived fission products in fallout, i.e., maximum in spring and minimum in autumn, varies by latitude and the maximum and minimum lag about a month per 10° of latitude from the lower middle latitude to the higher. This may be qualitatively explained by the inclusion of the lower stratospheric air into the troposphere following the seasonal transit of the polar and tropical tropopause. (BBB)

36160 COPENHAGEN RADIOCARBON MEASUREMENTS. VIII. GEOGRAPHIC VARIATIONS IN ATMOSPHERIC ^{14}C ACTIVITY. Tauber, Henrik (National Museum, Copenhagen). Radiocarbon, 9: 246-56(1967).

Measurements of bomb-produced ^{14}C in cereals and grasses in the northern hemisphere from 1956 through 1966 are presented. Samples were measured to determine the yearly addition of ^{14}C at a single locality, and to detect possible geographic variations in the distribution and uptake of bomb-produced ^{14}C in terrestrial plant material during years with greatly varying additions of ^{14}C. Measurements are given in per mil ^{14}C excess over natural ^{14}C level. (R.C.K.)

36161 STUDIES ON THE BEHAVIOR OF FISSION PRODUCTS IN THE LOW STRATOSPHERE. Cagnetti, P. (CNEN, Rome). G. Fis. Sanit. Prot. Radiaz., 10: 134-40(Apr.-June 1966). (In Italian). (RT/PROT(66)25).

Acceptable theories on the behavior of fission products from the time of the explosion to the time of their accumulation on the ground, some features concerning the passage of fission products into the troposphere from the low stratosphere, through the tropopause are examined. The mean time required for the passage of fission products through the tropopause at the time of the maximal transfer is calculated from the experimental data regarding the accumulation on the ground of the various radionuclides considering the mean time during which fission products remain in the troposphere to be one month. (tr-auth)

36162 BETA RADIOACTIVITY OF ARTIFICIAL ORIGIN IN THE ATMOSPHERE OVER BUDAPEST DURING 1961 TO 1965. Simon, Antal. Idojaras, No. 5, 261-5(1966). (In Hungarian).

Data on beta radiation of artificial origin, both from aerosols and from fallout, obtained at the Aerological Observatory during 1961 to 1965, are discussed. The mechanism of stratospheric fallout is analyzed and an attempt is made to determine the time it remains both in the stratosphere and the atmosphere. (JPRS)

36163 ^{155}Eu IN DEBRIS FROM NUCLEAR WEAPONS. Aarkrog, A.; Lippert, J. (Atomic Energy Commission, Riso, Denmark). Science, 157: 425-7(July 28, 1967).

The lithium-drifted germanium detector enables determination of europium-155 on a routine basis in environmental samples contaminated with debris from nuclear weapons. From measurements of europium-155, cesium-144, and strontium-90 in air filters collected between 1961 and 1966, the yield of europium-155 from weapons was estimated at 1400 atoms per 10^6 fissions, which is close to the yield of europium-155 from fast fission of uranium-238. (auth)

Mineralogy

Refer also to abstract 36343.

36164 ON THE RADIOACTIVITY LEVEL OF THE NEOGENE TERTIARY IN THE VICINITY OF SHIBATA CITY, NIIGATA

PREFECTURE. Bojo, Toshiatsu; Matsui, Hiroshi. Chishitsu Chosasho Geppo, 17: 472-9(Aug. 1966). (In Japanese).

The results of a radiometric survey and geologic investigation of the Neogene Tertiary in this area are described. An outline of geology in this area is shown; the Neogene Tertiary in Miocene age is divided into several formations. Among these formations, the Yamanokami conglomerate, the lowermost part of the Neogene Tertiary, overlies unconformably the granite (Kusozu-Kogawa type) and its thickness is 550 to 650 m in the southern part of this area. This formation is composed chiefly of coarse arkosic materials and abundant thin coal seams, and the survey of this formation was the main object of the survey. The other Neogene Tertiary in this area consists of some fine-grained sediments (mudstone and very fine sandstone) intercalating acidic pyroclastic rocks. The distribution and variation of radioactivity of each formation measured by scintillation counter are shown. For each formation the value of ratio of natural background to radioactivity level in the rocks is tabulated. The ratio of intensity in both the Kusozu-Kogawa granite (1.97) and the Yamanokami conglomerate (1.82) is larger than in the other formations. Accumulation of U was not detected by chemical analysis of 3 samples from the Yamanokami conglomerate which had a maximum ratio value of nearly 3.0. (BBB)

36165 MINERAL AND GEOCHEMICAL ZONATION OF INFILTRATION URANIUM ORES. Kashirtseva, M. F. Int. Geol. Rev., 9: 100-9(Jan. 1967).

In infiltration U deposits in the zone of supergenesis, U ores occupy a definite position within the epigenetic zonation series arising in consequence of paragenetic changes imposed upon the already formed rock and succeeding each other spatially in an orderly sequence. The following 4 zones were determined and mapped: the zone of surficial oxidation in the outcrops themselves; the zone of horizontal oxidation, along aquifers and below the ground-water table, invariably confined between some two epigenetically unaltered water-impervious horizons; the zone of U accumulation over unoxidized rocks and in contact with the zone of horizontal oxidation (this zone consists of 3 subzones: gray low-grade ores, black ores, gray ores); and unoxidized rocks. Uranium content in the U accumulation zone probably is determined to some extent by the redox-potential gradient. In turn, this gradient probably depends on composition of the ore-carrier rocks, primarily on the mode of Fe occurrence. Data for 3 horizons with different U concentrations and different ratios of Fe occurrences were correlated. A considerably higher U and epigenetic iron sulfide content was observed at the boundary between oxidized and unoxidized rocks of horizon I, where sulfide Fe was conspicuous (accounting for 36% of total Fe in the unaltered rocks and 49% of the contact). Where carbonate Fe was the dominant form, as in horizon II (61.1% of the total Fe), U content at the formation oxidation zone contact was low. In that event, U and Fe precipitation proceeded simultaneously. Where the sulfide iron was inconspicuous, as in horizon III (4% of total Fe), neither U nor epigenetic pyrite concentrations were observed at the oxidation zone boundary. Rocks with predominantly sulfide Fe showed the steepest redox potential gradient, which promoted a considerable U accumulation. Conversely, rocks with predominantly carbonate Fe were unfavorable for U accumulation. (BBB)

36166 RESUMPTION OF URANIUM PROSPECTING IN SOUTH AFRICA IS NEEDED. von Backstrom, J. W. S. Afr. Mining Eng. J., 980-2, 984(Apr. 28, 1967).

Present U reserves in South Africa, U ore price considerations, airborne and land radioactivity surveys, geophysical exploration, and other aspects of U prospecting are discussed. Known deposits are not capable of supplying low-cost U at the continually increasing rates called for beyond 1975; therefore, substantial additions must be made to world reserves of U ores within the next 10 yr to meet requirements of the projected increase in nuclear generating capacity. If prospecting on an adequate scale is resumed soon enough, the additional reserves required may be revealed and prices held at a reasonable level throughout the decade. Unless adequate reserves of low cost ores are discovered within the Republic of South Africa within the next decade, the nation will lose the position of having the second largest reserves of U in the western world. Short-term and long-term availability of U is discussed. This short-term potential refers to developed areas within the Witwatersrand system (from which most of the production is now coming). With an $8.00 price, this short-term potential is estimated at about 180,000 of U_3O_8 at the present gold price. Exploration outside the Witwatersrand triad undertaken with a car-mounted radiometric apparatus is described. Reconnaissance flights over routes which had previously been traversed with the car-mounted apparatus proved that an airborne survey is much better suited and effective in the detection of radioactivity anomalies and also in the elucidation of general geological problems. Low flying is a prerequisite to a successful survey. At 100 ft or less, with the proper technique, a survey should be able to detect an outcrop several hundred square feet in area, of an average grade of 0.1% U_3O_8. There is no relation between the size of the anomaly as indicated in the air and the amount of U present. The evaluation that can be made from the air is whether or not the anomaly is worthwhile investigating. (BBB)

36167 ON THE RADIOACTIVITY LEVEL AND URANIFEROUS BEDS OF THE NEOGENE IN MIKAWA-MURA AND ITS VICINITY, NIIGATA PREFECTURE, NORTHEASTERN JAPAN. Bojo, Toshiatsu; Aoyagi, Nobuyoshi; Suzuki, Taisuke. Chishitsu Chosasho Geppo, 17: 459-71(Aug. 1966). (In Japanese).

In the Yoshigasawa and Akatani areas, Mikawa-mura, Niigata prefecture, uraniferous beds were discovered at the basal part of the Neogene Tertiary (Miocene) sediments. Extensive geologic and radiometric surveys were made of the Neogene sediments exposed within these districts and adjacent areas. The Neogene sediments in the area lying unconformably on basement rocks (granites, Paleozoic formation) are divided into the Mikawa group, the Tsugawa formation and the Awase formation, in ascending order. However, it seemed that the Tsugawa formation directly overlies the basal granites because of thinning of the Mikawa group in the Yoshigasawa and Akatani areas. Uranium occurred only at the lowest part of the Tsugawa formation, consisting of arkosic sandstone and conglomerate. Chemical analyses of rock specimens at the outcrops of both areas showed 0.02 to 0.15% U_3O_8 in Yoshigasawa and 0.06 to 0.14% U_3O_8 in Akatani. It was noted that U had a tendency to be concentrated in carbonaceous matter (thin coal seams) scattered in the sandstone or conglomerate, but the extension of uraniferous deposits was limited. No remarkable radioactive anomalies were detected in the Neogene in the areas, except those mentioned above. (BBB)

36168 ON THE RADIOACTIVITY LEVEL OF THE TERTIARY BEDS IN THE TSUGAWA AREA, NIIGATA PREFECTURE. Aoyagi, Nobuyoshi; Bojo, Toshiatsu. Chishitsu Chosaho Geppo, 17: 451-8(Aug. 1966). (In Japanese).

Radioactivity surveys were made on the neogene sediments in the Tsugawa area. The tertiary sediments, lying unconformably on Paleozoic formation (partly on granitic rocks) in this area, include 3 formations: the Tsugawa, Awase, and Tokonami formations, in ascending order. The Tsugawa formation is divided into 2 members: Kannonzawa conglomerate and Hirotani tuff members. The former is the basal conglomerate of the Tertiary in this area and known as the sediments containing Comptoni phyllum-Liquidambar flora in its basal parts. This member also contains the mollusc fossils, which are enumerated, at several points in its sandy parts. The Hirotani tuff member, which is accompanied by liparite, is the upper member of this formation. Radioactivity anomalies were found in the basal parts of the Tsugawa formation in the adjacent area, but in the field studied no anomaly was seen at the same horizon of the Tsugawa formation in this survey. The radioactivity levels of the upper 2 formations, the Awase and Tokonami, were lower than those of the Tsugawa formation in this area. (BBB)

36169 PROBLEM OF THE CONNECTION BETWEEN THE MINERALIZATION OF URANIUM AND ACIDIC ROCK EXTRUSIONS. Konstantinov, V. M. At. Energ. (USSR), 22: 416-17 (May 1967). (In Russian).

The close correlation between the confined location of uranium ores and acidic, subvolcanic intrusions has been pointed out repeatedly. It was attempted to resolve this question by a close study of the uranium content of Devonian igneous rocks containing extrusions, primarily felsites and porphyries. Both gradual and abrupt contact regions were noted but between rocks of different ages, the contact areas were always abrupt, often involving lava brecciation. The uranium-bearing minerals were always found to lie in the extrusions, at the contact region, or in the surrounding rocks, several hundreds of meters removed from the contact region. Quantitative analysis on quartzo- and granito-porphyries which did not undergo thermal changes, revealed that the igneous rocks have a higher uranium content than the clarkeites; this concentration is reduced by the recrystallization from felsitic to porphyric rocks. Reduction of the uranium content from older toward more recent rocks within the same intrusion complex may be due to the separation of the gas and liquid phases; this may be the primary cause of the subsequent formation of uranium-bearing hydrothermal rocks, and may be considered an indicator of hydrothermal uranium minerals. (TTT)

36170 A STUDY OF GOLD AND URANIUM DISTRIBUTION PATTERNS IN THE KLERKSDORP GOLD FIELD. Krige, D. G. Geoexploration, 4: 43-53(Mar. 1966).

The application of the 3-parameter lognormal frequency-distribution model to Au and U values in the Klerksdorp mines and the relation between the logarithmic variance and the size of reef area over the full range from 0.1 to 1000 million ft^2, are

dealt with. Also the nature of the 2-dimensional distribution patterns or trend surfaces encountered and the extent to which the knowledge of these features has led to improved ore valuation techniques are examined. This field is a very important U carrier and the U reserves in this field form the major part of South Africa's total U potential. The similarities and differences between U and Au patterns are outlined. The U values were generally less variable than the Au values (based on inch-pennyweight), with an absolute dispersion, within mines, of 0.014. The theory of similitude in U and Au distribution although applicable up to areas equivalent to individual mine properties, seemed to break down for mines as units within the field as a whole, suggesting that for U the geological factors affecting the value distributions were not as stable over the full range of ore unit sizes, as those affecting the Au distributions. Studies of various geological factors which could be correlated with Au and U distributions are being undertaken and may assist in clarifying the true nature and origins of the various U distribution patterns in this and other gold fields. (BBB)

36171 THE EVANSITE OF PISOES (MONTALEGRE, CHAVES). Neiva, Ana M. R. Publ. Museu Lab. Mineral. Geol. Univ. Coimbra Centro Estud. Geol., Mem. Notic., No. 57, 21-8(1964). (In Portuguese).

The evansite of Pisões [$Al_3PO_4(OH)_6 \cdot 6H_2O$] is supergene and it is deposited in the diaclases on the surface of the granitic outcrops and sometimes covers granitic blocks. It is amorphous, with colloform structure, it is radioactive because it has thorium, its chemical analysis is characteristic of this mineral, from a thermal and roentgenographic study it was verified that it is amorphous, but it becomes crystalline at 970°C and at this temperature there is an exothermic peak. From 970°C to 1460°C it has a similar structure to the aluminum orthophosphate (orthorhombic). (auth)

36172 THE GENETIC SIGNIFICANCE OF THE SIZE DISTRIBUTION OF URANINITE IN WITWATERSRAND BANKETS. Koen, G. M. Trans. Proc. Geol. Soc. S. Afr., 64: 23-54(1961).

A size analysis was carried out on the uraninite, zircon, and chromite fractions of several samples of Witwatersrand banket to investigate the possibility of hydraulic equilibrium existing between the uraninite and the detrital minerals. Study of the size data showed that the median grain sizes of the uraninite, zircon, and chromite fractions fluctuate sympathetically from sample to sample, and from reef to reef. The ratio between the median grain-sizes of these 3 fractions corresponds to the ratio calculated from theoretical considerations. The cumulative curves illustrating the various uraninite distributions show the same shape and gradient as the size distribution curves of the accompanying zircon and chromite fractions. The well-matched size distributions indicate that the uraninite grains were deposited together with the zircon and chromite fractions from a suspension in water. Hydraulic conditions favorable for the deposition of uraninite grains were not confined to the periods of banket deposition. Uraninite is, therefore, probably genetically linked with the special conditions pertaining during the formation of the bankets. It is suggested that uraninite was precipitated as minute compact nodules in the muddy floors of marshes or shallow lakes covering the peneplaned surfaces or flood plains during long intraformational breaks. The muddy deposits, containing the uraninite nodules, were reworked during the period of renewed wave-action initiating a new cycle of sedimentation, which caused the heavy grains to become concentrated and sorted, redistributed, mixed with other sedimentary material and eventually deposited together with the detrital components of the banket. This explains features such as the hydraulic equilibrium between uraninite and accompanying detrital minerals, the patchy distribution of uraninite in the banket, the tendency of the grains to form clusters, the occurrence of roundish aggregates composed of uraninite particles, and the presence of an occasional composite grain. (BBB)

Oceanography

36173 (AERE-M-1254) INVESTIGATION INTO THE EFFECTS OF DEEP SEA PRESSURES ON WASTE MATERIALS AND DISPOSAL CONTAINERS. Pearce, K. W.; Vincent, J. D. (Atomic Energy Research Establishment, Harwell (England)). Sept. 1963. 29p. Dep.

Background history and regulations governing sea disposal operations carried out by A.E.R.E., Harwell are discussed. The theoretical behavior of disposal containers in sea water is discussed and the results of limited tests carried out on different types of containers used are given. Experiments to ascertain the effect of hydrostatic pressure on waste materials are described. (auth)

36174 (RLO-1752-7) BOTTOM CURRENTS AND THE MOVEMENT OF SEDIMENT ACROSS THE CONTINENTAL SHELF. Progress Report, June 1, 1966-May 31, 1967. Creager, Joe S. (Washington Univ., Seattle. Dept. of Oceanography). May 1967. Contract AT(45-1)-1752. 10p. Dep. CFSTI.

Data are presented on bottom currents and movement of sediment across the continental shelf in a wide variety of environments. Sediment motion observed by divers, television, and stereo cameras had the appearance of suspended load rather than bed load movement. Data analysis indicated that processes of marine erosion are similar to those observed in laboratory experiments. Erosion relationships observed seem to be applicable to the marine environment in general. Field measurements were analyzed to determine the time-average boundary shear stress. A device for measuring instantaneous local velocity vector in a plane was constructed. (F.S.)

36175 (RLO-1725-72) CONTINENTAL SHELF SEDIMENT NEAR THE COLUMBIA RIVER, NORTHWESTERN UNITED STATES. Gross, M. Grant; McManus, Dean A.; Ling, Hsin-Yi (Washington Univ., Seattle. Dept. of Oceanography). Jan. 1967. Contract AT(45-1)-1725. 5p. (CONF-670803-1). Dep. CFSTI.

From 7th International Sedimentological Congress, Reading, England, and Edinburgh.

Properties of the sediment on the continental shelf near the Columbia River were studied. Among the properties studied were grain size, grain-size distribution, organic carbon content, $CaCO_3$ content, and deposition patterns. (W.E.B.)

36176 PROBABILISTIC TREATMENT OF A RADIOISOTOPIC FUEL RELEASE IN SHALLOW WATER. Hood, Darl S. (Martin Marietta Corp., Baltimore). Trans. Amer. Nucl. Soc., 10: 5-6(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36177 APPLICATION OF THE BOXES METHOD TO THE STUDY OF EXCHANGE PROCESSES AND THE DYNAMICS OF ^{90}Sr IN THE UPPER LAYER OF THE NORTH ATLANTIC. Koshlyakov, M. N. (Inst. of Oceanology, Moscow). Izv. Akad. Nauk SSSR, Fiz. Atmos. Okeana, 3: 742-56(July 1967). (In Russian).

The parameter ν^*, the effective velocity of exchange between boxes, is considered. It gives to the boxes model a more general character. The model is used for the study of the water exchange between the upper mixed layer in the North Atlantic and the adjacent water masses. Strontium-90 is chosen as a tracer. Bowen and Sugihara's data are used for the estimation of the strontium-90 concentration in the deep layers. Results of the computations indicate a strong exchange between the upper homogeneous layer and the underlaying layers. The residence time for the upper layer is equal to half a year and for the layer located between the upper layer and the main thermocline is about two years. The fallout of strontium-90 on the surface of the Atlantic is also estimated. This quantity is 1.7 times as large as the corresponding quantity for land. (tr-auth)

Seismology

36178 (NVO-1163-98) RAY THEORY SEISMIC PULSE (RATS PULSE): MATHEMATICS REPORT. Koo, B.; Loux, P. (Environmental Research Corp., Alexandria, Va.). Jan. 13, 1967. Contract AT(29-2)-1163. 50p. Dep. CFSTI.

The propagation of a compressional pulse in a solid half-space overlain by a solid layer of different properties was studied. Both the layer and half-space are homogeneous and isotropic. A source function which can be made to approach the unit step function is assumed, and the resulting exact analytic solutions for the time histories of the vertical and radial components of displacement (i.e., the vertical and radial displacement seismograms) are derived. The results of the analysis in this reference are extended to include the radial displacement, an arbitrary point of observation on or within the layer, arbitrary medium constants in both the layer and the half-space, and an arbitrary source depth within the layer. (auth)

36179 (NVO-1163-105) RAY THEORY SEISMIC PULSE (RATS PULSE): PROGRAM REPORT. Whitley, Virginia W. (Environmental Research Corp., Alexandria, Va.). Mar. 30, 1967. Contract AT(29-2)-1163. 38p. Dep. CFSTI.

An operational Fortran IV program, titled RATS, for use on a CDC 3600 system, is described. The program allows computation of the radial and vertical displacement time functions for the problem of propagation of a compressional pulse in a solid half-space overlain by a solid layer. (auth)

36180 SHORT-PERIOD SEISMIC ENERGY RADIATION PATTERNS FROM UNDERGROUND NUCLEAR EXPLOSIONS AND SMALL-MAGNITUDE EARTHQUAKES. Sutton, George H.; Mitronovas, Walter; Pomeroy, Paul W. Bull. Seismol. Soc. Amer., 57: 249-67(Apr. 1967).

Azimuthal radiation patterns of short-period (0.5 to 2.0 cps) seismic energy obtained from integrals of the seismograms from 2 underground nuclear explosions and 2 earthquakes were used to study the propagation and source characteristics of the Pg and Lg phases in the United States. In addition, the energy spectrum was divided into 2 bands, greater than and less than 1.4 cps, and the ratio of higher-to-lower-frequency energy was mapped to study the nature of propagation as a function of frequency. Both the total energy and ratio showed large fluctuations with azimuth and distance. However, a general correlation was found between the energy and ratio contours and the major tectonic provinces of the United States. This correlation was attributed to focusing, resulting from lateral variations in velocity and to regional differences in attenuation of the seismic energy. The range in the Q values across the United States, based on the assumption of symmetrical surface wave propagation, was from 200 to 1000, about factor of 5. The transverse (T) component showed about the same total energy and ratio contour patterns as the vertical (Z) and longitudinal (L) components. Also, energy contour maps were similar to maps obtained using the maximum amplitudes of the Pg and Lg phases. For the nuclear events and earthquakes examined, it seemed that the nature and distribution of tectonic features along the propagation path are more important in determining the resultant radiation patterns than the initial conditions at the source. The particle motion at most stations did not give direct proof for the surface wave nature of the Pg and Lg phases, except that Pg tended to be longitudinal or mixed and Lg transverse or mixed. (BBB)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 36178, 36179, 36310, 36311, 36313, 36318, and 36421.

36181 (DP-1106) DISTRIBUTION OF RADIOACTIVE ELEMENTS IN THE DEBRIS OF THE SALMON NUCLEAR TEST. Karraker, D. G.; Perkins, W. C. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). July 1967. Contract AT(07-2)-1. 14p. Dep. CFSTI.

Analysis of the debris of Salmon, an underground nuclear test detonated near Hattiesburg, Mississippi, showed that most of the isotopes formed during the explosion collected in a thin layer at the bottom of the original cavity. An explanation is offered for the vertical distribution of radioactive species in the debris. (auth)

36182 (NVO-1163-67) ANALOG COMPUTER STUDY OF BUILDING RESPONSE TO GROUND MOTION. Revised. Lynch, Robert D. (Environmental Research Corp., Alexandria, Va.). Mar. 1, 1967. Contract AT(29-2)-1163. 16p. Dep. CFSTI.

From velocity measurements made on five high-rise structures, an empirical transfer function that relates top floor absolute velocity to base velocity is determined. Examples of simulated top floor motion derived from base motion are given for comparison with measured top floor motion. (auth)

36183 (ORNL-TM-1932) CHEMICAL APPLICATIONS OF NUCLEAR EXPLOSIONS (CANE). Progress Report, April 1-June 30,1967. Blake, C. A. Jr.; Crouse, D. J.; Arnold, W. D. (comps.) (Oak Ridge National Lab., Tenn.). Aug. 3, 1967. Contract W-7405-eng-26. 16p. Dep. CFSTI.

During the dissolution of ^{106}Ru-contaminated cement copper in sulfuric acid, about $\frac{2}{3}$ of the ruthenium dissolved in the acid solution and the other $\frac{1}{3}$ remained in the insoluble sludge. About 0.3% of the soluble ruthenium deposited with 13% of the copper in the electrowinning of copper from this solution. More than 80% of the ruthenium was removed from the electrolyte solution by oxidation at 80°C with sodium persulfate. After shale oil had been heated with debris from a recent underground test shot, it was found to be contaminated with radionuclides, principally ^{95}Zr-Nb and ^{103}Ru. The contamination of the oil increased with increased heating temperatures. (auth)

36184 (PNE-505F) GEOLOGIC AND ENGINEERING PROPERTIES INVESTIGATIONS. Project PRE-SCHOONER. Final Report. Lutton, R. J.; Girucky, F. E.; Hunt, R. W. (Army Engineer Waterways Experiment Station, Vicksburg, Miss.). Mar. 1967. 204p. CFSTI.

The four Pre-Schooner high explosive cratering experiments were conducted in dry basalt on Buckboard Mesa, Nevada Test Site. The preshot and postshot conditions were investigated by core boring, borehole photography, geophysical techniques, aerial photography, and exploratory excavations. Representative core samples were tested in the laboratory for strength properties and specific gravity. The rock consists of vesicular basalt over dense basalt, each type structurally modified by layering of vesicles resulting from viscous flow of the lava. Two craters, explored by trenching, showed that displaced ground surface was uplifted about 5 ft at the true crater. In the subsurface beyond the true crater at the Delta Site, zones of blast fracturing and bulking were distinguished. These appear to be modified somewhat by the stratigraphy of the basalt. The limits of fracturing and bulking by the blast appear to lie at about 100 ft from the zero point. (J.R.D.)

36185 (PNE-1111) PRESHOT GEOPHYSICAL MEASUREMENTS. Project PRE-GONDOLA I. Stearns, R. T.; Rambo, J. T. (California Univ., Mercury, Nev. Lawrence Radiation Lab.). Apr. 11, 1967. Contract W-7405-eng-48. 58p. Dep. CFSTI.

A series of preshot downhole geophysical measurements was performed at three out of the four locations on the Pre-Gondola I site near Glasgow, Montana. These in situ measurements in nearly homogeneous shale included density, gamma ray-neutron, caliper, electric, three-dimensional velocity, continuous velocity and seismic uphole-downhole logging. All measurements except gamma ray-neutron and electric logging appear to have yielded useful quantitative data. Average densities ranged from 2.11 to 2.42 g/cm^3, and average velocities fluctuated between 1732 and 2014 m/sec below the weathered zone. Density measurements performed by the U. S. Army Engineer, Omaha District, compared favorably with those made by LRL. An opportunity to compare in situ sonic velocities made by three different tools in the same hole showed a variation in measured value with the method used. These data suggest that the distance between wave source and detector is responsible for the variation in measured velocity. (auth)

36186 (PNE-1200) PROJECT KETCH: A FEASIBILITY STUDY ON CREATING NATURAL GAS STORAGE WITH NUCLEAR EXPLOSIONS. (Columbia Gas System Service Corp., Columbus, Ohio. San Francisco Operations Office (AEC), Calif. California Univ., Livermore. Lawrence Radiation Lab. Bureau of Mines, Washington, D. C.). July 1967. 55p. Dep. CFSTI.

The feasibility of using nuclear explosives to create underground gas storage was examined to help fill a growing need for natural gas storage capacity. The nation now has less than 4½ trillion cubic ft of such storage and could use an additional 5 trillion cubic ft if available at low cost. A contained underground nuclear explosion produces void space which could be used for storage of natural gas near the consumer end of natural gas transmission lines. Storage facilities so developed offer the potential of being economically superior to mined cavities and cryogenic natural gas facilities. They may also be competitive in areas where natural storage in depleted gas fields exists but is growing scarce, or where rapid deliverability of stored gas is a factor. A site approximately 12 miles southwest of Renovo, Pennsylvania, has been selected for illustrative purposes to evaluate this gas storage concept. The design for Project Ketch at Renovo calls for detonating a 24-kiloton nuclear explosive at a depth of 3,300 ft in a thick impermeable shale formation. The detonation would create a rubble filled chimney with a radius of 90 ft and a height of about 300 ft. Fractures are not expected to extend beyond 650 ft above the detonation point. There would be no air blast effects, and radiation effects would be safely contained underground. This void space would permit storage for about 465 million standard cubic ft of gas at 2100 psi pressure. (J.R.D.)

36187 (UCRL-6759(Vol.1)(Rev.1)) HIGH EXPLOSIVES HANDBOOK. VOLUME 1. REVISION 1. (California Univ., Livermore. Lawrence Radiation Lab.). July 1967. Contract W-7405-eng-48. 82p. Dep. CFSTI.

Information in handbook form on primary explosives, high explosives, squibs and primacord, adhesives, fillers and coatings used with explosives, and solid propellant gas generators is provided for use in the design of nuclear systems. (F.S.)

36188 (UCRL-7804) FALLOUT CALCULATIONS AND MEASUREMENT. Williamson, M. M. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 1964. Contract W-7405-eng-48. 23p. (CONF-470-10). Dep. CFSTI.

From 3rd Plowshare Symposium on Engineering with Nuclear Explosives, Davis, Calif., Apr. 1964.

Discussions of fallout and definitions of terms peculiar to discussions of fallout problems are presented. Sources of radioactivity and types of radiological hazards as they pertain to nuclear excavation are also discussed. The steps which might be taken in the preshot planning and postshot evaluation of fallout problems as applied to a nuclear excavation project are outlined. The preshot planning phase includes a discussion of the data necessary for fallout prediction, fallout prediction techniques, and interpretation of the fallout prediction in terms of on-site and off-site radiological safety. The postshot phase includes discussions of data which must be collected after firing, how these data may be collected, and how the data are used for fallout pattern construction. Other calculations necessary to evaluate radiological hazards are included. Interpretation of the fallout pattern to determine reentry times is also discussed along with on-site and off-site radiological hazards, and the fraction of the total activity vented as prompt fallout. (auth)

36189 (UCRL-50276) RESEARCH FOR UNDERSTANDING AND CONSTRUCTIVELY USING UNDERGROUND NUCLEAR EXPLOSIONS. Rodean, Howard C. (California Univ., Livermore. Lawrence Radiation Lab.). June 6, 1967. Contract W-7405-eng-48. 53p. Dep. CFSTI.

Unclassified research directed toward the understanding of underground nuclear explosion phenomena and constructive applications for nuclear explosions are described. Physical measurements of ground motion generated by explosions are used together with the equations of state, chemical and thermodynamic theory, and the laws of continuum mechanics to develop mathematical models used to predict explosion phenomena. Postshot exploration is necessary to determine the residual explosion effects, such as heat deposition, rock fracturing, and chimney for-

mation. These explorations give physical and chemical clues that aid in the interpretation of the experiment. Furthermore, the residual effects are of interest in many engineering applications. Safety considerations include airblast and seismic motion that may damage property and radioactivity that may be a health hazard. Significant progress has been made in predicting airblast, ground motion, and radioactivity distribution. Nuclear explosions are intense sources of neutrons; therefore, experiments are conducted to measure neutron cross sections and to produce heavy elements. The heaviest nuclide produced to date has a mass number of 257. The seismic waves generated by nuclear explosions have been used by geophysicists for over two decades to determine the internal structure of the earth with a precision not possible with earthquakes. Finally, research is under way to relate the effects of an explosion to its intended use (in the petroleum industry, for example). (auth)

36190 SHIELDING EFFECTIVENESS OF SOILS AGAINST INITIAL RADIATION. Wilson, J. H.; Karcher, R. H. (Holmes and Narver, Inc., Los Angeles). Trans. Amer. Nucl. Soc., 10: 407-8(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36191 IMAGE FURNACE FOR LOW YIELD NUCLEAR WEAPONS EFFECTS SIMULATION. Griff, Neil; Heilferty, Robert J.; Derksen, Willard L. (Naval Applied Science Lab., Brooklyn). Rev. Sci. Instrum., 38: 1217-20(Sept. 1967).

The capability of the Naval Applied Science Laboratory for direct simulation of thermal effects due to nuclear weapons has been extended to low yield devices [as small as 10 kilotons (kt)] by the installation of a high performance servo-driven shutter in a carbon arc imaging furnace. The system can simulate thermal radiation pulses from atmospheric detonations with yields of from 10 kt to the largest devices. It can deliver a maximum irradiance of 190 J cm^{-2} sec^{-1} over an effective spot diameter (irradiance at least 90% of maximum) of approximately 17 mm using a single ellipsoidal mirror. With the addition of a second mirror, a maximum irradiance of over 850 J cm^{-2} sec^{-1} can be obtained with an effective spot diameter of about 4 mm. Arbitrary pulse shapes can also be delivered. Provision is made to record irradiance histories and source characteristics during each exposure without appreciably interfering with sample irradiation. (auth)

36192 NUCLEAR CRATERING EXPERIMENT. S. Afr. Mining Eng. J., 693(Mar. 24, 1967).

Since the Plowshare program was established in 1957, 16 nuclear field experiments and extensive laboratory research have been conducted and data derived from numerous nuclear tests conducted for other purposes. From this work an understanding of the basic phenomena of underground nuclear explosions is evolving. When a nuclear explosion occurs deep underground in hard rock it produces a large amount of broken rock, but does not break the surface. When the explosion occurs at a lesser depth, a crater is formed in the surface. The basic effects of explosions in a variety of geologic media and under a variety of conditions, and how these effects can be put to use, are being studied. Results indicate that nuclear explosives might be used for large-scale projects such as constructing harbors, water reservoirs, ship canals, and highway and railroad passes through mountain ranges. Another potential application, the use of nuclear explosives to dig a sea-level canal, is being investigated. Project Cabriolet, a recent step in this development program, is discussed. The information obtained from this experiment will be used in developing the understanding of how craters are formed. In turn, this understanding is expected to result in increased confidence in predicting the characteristics of craters in other types of rock and from larger explosions. Data from field experiments, such as Cabriolet, combined with the most advanced knowledge of the physical and chemical properties of rocks and explosion phenomena, provide the input to complex computer calculations which produce a description of the entire cratering process. Thus, this cratering experiment will improve the computer calculations, and, hence, the overall description of the cratering phenomenon. (BBB)

36193 COMPUTER CALCULATIONS OF EXPLOSION-PRODUCED CRATERS. Cherry, J. T. (Univ. of California, Livermore). Int. J. Rock Mech. Mining Sci., 4: 1-22(Jan. 1967).

A technique is presented for calculating, from first principles, the mound and cavity growth that occur during nuclear and high-explosive cratering events. It features a standard, numerical approach to high-intensity, stress-wave propagation coupled with a unique model of material behavior in brittle failure. A preshot testing program is presented which obtains the necessary material properties from logging tests in the medium and from lab tests of selected rock samples. In situ properties to be determined by field logging are density and elastic velocity (compressional and shear velocity). Calculations are presented for Project Hardhat (5 kt, nuclear in granite), Project Scooter (0.45 kt, high-explosive in alluvium), Project Danny Boy (0.42 kt, nuclear in basalt), Project Sulky (0.09 kt, nuclear in basalt), and 3 parameter studies featuring rhyolite equations-of-state. The Danny Boy calculation confirmed spalling to be the predominant nuclear cratering mechanism in hard, dry rock. This observation permitted the construction of a free-fall, throw-out model which gave a reasonable estimate of crater radius and ejecta boundary. (BBB)

36194 METHOD FOR PROVOKING A NUCLEAR EXPLOSION. (to Soc. An. SEPI). French Patent 1,331,491. May 27, 1963. Filed May 22, 1962.

The detonating device consists of two spaced coaxial coils, in the axis of each of which is placed a subcritical mass of a nuclear explosive. The masses are coated with Al or Cu. The coils are connected with a battery of charged electric condensors in such a way that the current generated by discharge of the battery will pass simultaneously through both coils. As soon as the battery is discharged the subcritical masses will be propelled to each other. (auth)

36195 METHOD FOR PROVOKING A NUCLEAR EXPLOSION. (to Soc. An. SEPI). French Patent 1,332,110. June 4, 1963. Filed June 1, 1962.

Two subcritical masses are propelled to each other by means of magnetic repulsion forces. (auth)

36196 METHOD OF MANUFACTURING ATOMIC BOMBS. Pozwolski, A. E. French Patent 1,376,048. Sept. 14, 1964. Filed Nov. 9, 1963.

A light-weight atomic bomb is described in which the critical mass is fabricated in the configuration that is needed for explosion. Premature explosion is prevented by the presence of one or more inserted tubes filled with compressed BF_3 or B_2H_6. These tubes are closed by diaphragms which carry a small conventional explosive charge. If the charges are detonated, the neutron absorber escapes and the chain reaction starts immediately. (auth)

Facilities and Equipment

Refer also to abstracts 35885, 36191, 36257, 36265, 36307, 37340, 37341, 37345, 37346, 37366, 37402, 37403, 37405, 37406, 38837, 38843, 38859, 38866, and 38868.

36197 (AERE-M-1720) UNIVERSAL ULTRASONIC MACHINE TOOL FOR GLASS AND CERAMICS. Legge, P. (Atomic Energy Research Establishment, Harwell (England)). Feb. 1966. 15p. Dep.

The development of an ultrasonic machine tool for glass and ceramics utilizing a special rotary transducer-converter head and diamond impregnated tools is described. The main features of the machine, the construction of the transducer-converter head, the hydraulic pressure control system and ancillary attachments are detailed. Machining trials including the drilling, trepanning, slotting, thread cutting and surface grinding of glass and alumina are also described. (auth)

36198 (BNL-724) ADSORPTION OF KRYPTON AND OF MIXED XENON AND KRYPTON ON ACTIVATED CHARCOAL. Eshaya, A. M.; Kalinowski, W. L. (Brookhaven National Lab., Upton, N. Y.). Mar. 1961. 7p. Dep. CFSTI.

The dynamic adsorption of Kr and of mixed Kr and Xe from He mixtures was investigated on a small charcoal bed by measuring the shapes and positions of breakthrough curves. The adsorbent used in this study was Columbia grade HCC 12/28-mesh. The experimental variables were flow rate, concentration, and bed temperature. Flow rates in the range 1500 to 5000 cc/min were used in an activated charcoal bed 10.5 in. long by 1.38 in. in diameter. The inlet concentration varied from 0.025 to 0.1% Kr and the bed temperature from 25 to 100°C. It was concluded that the adsorption of Kr is similar to that of Xe, and that in the adsorption of the mixtures each gas behaves as it did when alone. (auth)

36199 (BNWL-CC-1182) FFTF PLANT FIRE PROTECTION SYSTEM: FIRE HAZARDS ANALYSIS. Taylor, W. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1967. Contract AT(45-1)-1830. 15p. Dep. CFSTI.

Fire potentials in various parts of the Fast Flux Test Facility were determined based on the usage of specified areas. The presence of large volumes of Na, wall and floor penetrations, drainage, and occupancy of adjacent areas limit the use of conventional systems of fire extinguishing. (F.S.)

36200 (EUR-3460,d) ENTWICKLUNG GROSSER STAHLBEHAELTER IN MEHRLAGENBAUWEISE. Jahresbericht Juli 1965 bis Juli 1966. (Development of Multilayer Large Steel Vessels. Annual Report, July 1965–July 1966). (Fried-Krupp, Essen (West

Germany). Zentralinstitut fuer Forschung und Entwicklung). May 1967. Contract 037-64-7 TEED. 53p. (In German). Dep.

Studies of the normalized, hardened, and heat-resistant steels included: chemical composition; strength and toughness properties at room temperature and higher temperatures; aging; tensile fatigue tests; Wöhler curves; and justification of selection of steel HSB55C and HSB77V. Welding studies included: heat-affected zone of base metal; hardening or softening, bending angle and toughness in transition zone; filler materials; preheating temperatures; static and dynamic stresses on three-piece corner seams; stress orientation; seam form; and electrode material. Photoelastic models of three-piece corner seams; stress concentrations; thermal conductivity of multilayer wall; surface roughness of plates; contact pressure; heat transfer coefficient; photoelastic models of pipe branches; bowing parameters; diaphragm and bending stress; point of maximum stress; and form factors are discussed. Devices for the construction of singly or doubly curved sections are described. Stresses at transition between cylinder and head were calculated. Equations, calculation program data as a function of ratio diameter/wall-thickness, and shear-free strengthening are discussed. Status of development work on first model vessel is reported. (auth)

36201 (NAA-SR-12444) CONSTRUCTION AND OPERATION OF A SODIUM PURIFICATION APPARATUS. McKisson, R. L.; Eichelberger, R. L.; Ott, J. B. (Atomics International, Canoga Park, Calif.). July 15, 1967. Contract AT(04-3)-701. 45p. Dep. CFSTI.

An apparatus for purifying sodium by a process involving hot gettering and distillation through a fractionating column was constructed and operated with success. Gettering was accomplished by the use of zirconium foil at 650°C. The gettered sodium was distilled at 550°C through a packed column equivalent to two theoretical distillation plates. The product sodium has fewer and lower concentrations of metallic impurities than does a 99.999% pure spectroscopic-grade sodium chloride standard. The oxygen content of the sodium product ranges downward from 5 to 0.6 ppM, the latter value having been obtained in the latest preparation. (auth)

36202 (NP-16688) ISSLEDOVANIE PREDPROBOINOI PROVODIMOSTI I PROBOYA MEZHDU ELEKTRODAMI V VAKUUME PRI POSTOYANNOM NAPRYAZHENII. (Investigation of Pre-Breakdown Conductivity and of Breakdown Between Electrodes in Vacuum at Constant Voltage). Gordienko, V. I. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1965. 97p. (In Russian). Dep.

Thesis.

A review of the previous literature is given (105 references). Previous theories considered exchange between charged particles, the removal of small bits of matter from the electrodes, and thermionic emission as the reasons for prebreakdown current flow and arcing in high vacuum at high voltage. However, at present, there is no generally acceptable theory for this phenomenon. The experimental setup consisted of a cylindrical copper tube 200 mm in diameter and 1300 mm in length. A high-voltage lead from a cascade generator through a plexiglass insulator was used to put one of the electrodes under high voltage. A vernier screw on the second electrode was used to vary the distance between electrodes from 0 to 30 mm with an accuracy of 0.02 mm without breaking the chamber vacuum, which was held at 1 to 3×10^{-6} mm Hg std. Currents from 10^{-5} to 10^{-12} amps were measured on a strong electrometer; larger currents were measured on a galvanometer. The total amount of charge was measured by discharge of calibrated condensers. Electrodes were made of Cu, Ni, Mo, Al, Pb, and steel. The results showed that microdischarges due to heavy particles and not to electrons represent the initial stage of the prebreakdown conductivity in long vacuum gaps. The microdischarges were sensitive to changes in applied voltage. The amount of charge per microdischarge varied considerably during the prebreakdown period. A high vacuum of 10^{-10} mm Hg std was obtained by outgassing at high temperature. The anode and cathode processes were investigated in the high vacuum. The microdischarges disappeared due to the clean surfaces, but ion and electron currents were observed at relatively low voltages. (TTT)

36203 (ORNL-TM-1902) DESIGN OF A JET-ACTUATED VACUUM SYSTEM FOR USE IN THE COATED PARTICLE DEVELOPMENT LABORATORY, BUILDING 4508. Rom, A. M. (Oak Ridge National Lab., Tenn.). June 26, 1967. Contract W-7405-eng-26. 11p. Dep. CFSTI.

A jet-actuated vacuum system has been designed to serve the microsphere producing operation in the Coated Particle Development Laboratory. This system is simple and inexpensive, and can easily be made critically safe by limiting equipment diameters to 4 in. or less and by maintaining an edge-to-edge spacing of at least 12 in. between adjacent items of equipment, all of which are located in the same plane. The performance curve for the jet exhauster, supplied by the manufacturer, shows that it can evacuate a closed system, with essentially zero inleakage, to a stable absolute pressure approaching 1 in. Hg; at loadings of 6.75 and 31 lb of air per hour, it will maintain absolute pressures of 3 in. and 10 in. Hg, respectively. Other similar information may be obtained from the curve. Exhaust steam leaving the jet exhauster is completely condensed, and the condensate is routed to "hot" waste; noncondensable gas, mainly air that is included in the jet exhaust, is vented to the building off-gas system. In addition to the exhauster, the system is comprised of a Pyrex vacuum accumulator, two shell-and-tube heat exchangers, and a vent pot. All the items of equipment are mounted in a single plane on the outside south wall of the sphere forming enclosure. An edge-to-edge spacing of at least 12 in. between adjacent items was maintained. (auth)

36204 (ORNL-TM-1936) STACKED-CLONE CONTRACTOR: A HIGH-PERFORMANCE HYDROCLONE SOLVENT EXTRACTION DEVICE. Whatley, M. E.; Groenier, W. S.; Woods, W. M. (Oak Ridge National Lab., Tenn.). Aug. 7, 1967. Contract W-7405-eng-26. 37p. Dep. CFSTI.

The stacked-clone contactor, which is a high performance liquid-liquid solvent extraction device, has been developed to the point where a stainless steel prototype using integral pumps and capable of application to radiochemical processing has been designed and fabricated. The principle of operation, using individually driven hydraulic cyclones coupled by the induced underflow effect, has been shown to be applicable to many different solvent extraction systems including 100% tributylphosphate vs 3 M sodium nitrate, methyl isobutyl ketone vs dilute acetic acid and 120 cp mineral oil vs dilute nitric acid. Extraction stage efficiencies are generally about 70% for the less viscous systems but drop to about 30% for the very high viscosity systems. Throughputs which reduce the contact time to less than 3 sec per physical stage have been realized. (auth)

36205 (SAN-679-1) ELECTRICAL COMPONENT TECHNOLOGY FOR 0.25 TO 10.0 MEGAWATT SPACE POWER SYSTEMS: DESIGN STUDY. Quarterly Technical Progress Report No. 1, September 1-November 30, 1966. King, A. E. (ed.) (Westinghouse Electric Corp., Lima, Ohio. Aerospace Electrical Div.). Aug. 1967. Contract AT(04-3)-679. 154p. Dep. CFSTI.

Background technology, design philosophies, and parametric screening study plans are presented on ac generators, ac motors, power conditioning and power distribution equipment for 0.25 to 10.0 megawatt space nuclear electric power plants utilizing the Rankine conversion cycle. The power conditioning and distribution equipment includes transformers, rectifiers, frequency changers, contactors and transmission lines. Radiation degradation of electrical components is considered. Progress on experiments to verify analytical techniques for inductor generator designs typical of high-power, high-speed, high-frequency, high-temperature applications is included. (auth)

36206 (SAN-679-2) ELECTRICAL COMPONENT TECHNOLOGY FOR 0.25 TO 10.0 MEGAWATT SPACE POWER SYSTEMS: DESIGN STUDY. Quarterly Technical Progress Report No. 2, December 1, 1966-February 28, 1967. King, A. E. (ed.) (Westinghouse Electric Corp., Lima, Ohio. Aerospace Electrical Div.). Aug. 1967. Contract AT(04-3)-679. 233p. Dep. CFSTI.

Progress on parametric studies to determine minimum system weight as a function of electrical component rating, voltage, frequency and speed are presented on ac generators, ac motors, power conditioning and power distribution equipment for 0.25 to 10.0 megawatt space nuclear electric power plants utilizing the Rankine conversion cycle. The power conditioning and distribution equipment includes transformers, rectifiers, frequency changers, contactors and transmission lines. Final parametric data are presented on frequency changers in the 5 to 500 kva range as well as on contactors in the 0.05 to 10.0 mva range. Electrical power uses and missions analyses are presented to illustrate electrical load breakdown on probable missions requiring 0.25 to 10 megawatts of power. Progress on experiments to verify analytical techniques for inductor generator designs typical of high-power, high-speed, high-frequency, high-temperature applications is presented. Analysis of tests to verify magnetic forces between an eccentric rotor and stator of an inductor alternator is included. (auth)

36207 (TID-23872) POLICY CONSIDERATIONS IN DESALTING AND ENERGY DEVELOPMENT AND UTILIZATION. Ramey, James T. (Atomic Energy Commission, Washington, D. C.). July 1967. 20p. Dep. CFSTI.

Desalting water with nuclear energy provides fresh water and energy at the same time. Requirements for water and power de-

termine whether the development of dual purpose reactors is necessary. The economy of the energy source must be considered and alternate ways of producing fresh water and power must always be evaluated. The consideration of how much it is worth to have a minimum supply of water which is not subject to interruption by drought or other causes must be determined. The task of meeting worldwide interest and needs in desalting is too large for one nation but the U. S. hopes to develop desalting technology which can provide low cost water and to share this technology with the world. (F.S.)

36208 (TRG-Report-1409) SPANDE: A PRELIMINARY GUIDE TO SPACE-FRAME AND PIPEWORK ANALYSIS BY MEANS OF A GENERAL-PURPOSE COMPUTER PROGRAM. Davies, D. C.; Enderby, J. A. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Apr. 3, 1967. 41p. Dep. CFSTI. UK 6s. 0d.

A general-purpose program for the analysis of three-dimensional frameworks, with additional refinements for pipework systems, was developed for use on an IBM 7090 computer. The immediate objective is the analysis of structural space-frames and pipework systems by a method which allows a virtually unlimited number of redundancies, but other problems such as the analysis of certain asymmetric shell problems come within its scope. When used for pipework systems, the maximum shear stress in the pipe at each node and at the mid-point of each bend is quoted as part of the output data in addition to the internal forces and moments for each length, the displacements and rotations of each node and the reactions at each point of restraint. The members comprising the system being analyzed may be either straight or of constant curvature between nodes, provided that in the case of curved members one of the principal axes of the cross-section of the member lies in the same plane as the member. Any combination of forces, moments or displacements may be imposed at some or all of the nodes. Sufficient information is provided to enable the program to be available for general use in its present form. Application of the program is illustrated in the appendices by reference to a simple space-frame, a pipework system and a cylindrical shell. (auth) (UK)

36209 HIGH-FLUX GRAPHITE RESISTANCE HEATERS. Babbe, Everett (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 10: 145-6(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36210 GRADUATE ENGINEERING PRACTICE SCHOOL. Lucey, John W. (Univ. of Notre Dame, Ind.); Hang, D. F.; Wacks, M. E. Trans. Amer. Nucl. Soc., 10: 15(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36211 PREDICTION ANALYSIS OF THE GAUSSIAN FUNCTION. Wolberg, John R.; Segal, Y. (Technion-Israel Inst. of Tech., Haifa). Trans. Amer. Nucl. Soc., 10: 36-7(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36212 EFFECT OF FINITE CHANNEL WIDTH ON SPECTRUM BROADENING DUE TO PULSE PILEUP. Lilley, John R. (Douglas Aircraft Co., Inc., Santa Monica, Calif.). Trans. Amer. Nucl. Soc., 10: 37-8(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36213 COMPUTER METHOD FOR THE ANALYSIS OF COMPLEX GAMMA-RAY SPECTRA. Inouye, T.; Rasmussen, N. C. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 10: 38-9(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36214 FISSION-FRAGMENT RANGE MEASUREMENTS BY COMPUTERIZED ANALYSIS OF GAMMA-RAY SPECTRA. Osias, David (Cornell Univ., Ithaca, N. Y.). Trans. Amer. Nucl. Soc., 10: 39-40(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36215 A LARGE-VOLUME 6×10^3 THERMAL-NEUTRON FLUX FOR CONTINUOUS PRECISION ANALYSIS AND TRACER PRODUCTION. Downs, W. E. (Atomic Energy of Canada Ltd., Ottawa). Trans. Amer. Nucl. Soc., 10: 83-4(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36216 DESIGN AND PERFORMANCE OF THE IRRADIATION FACILITY "ROTATRON." Suess, S.; Grosse, W. (Pflanzenbau und Pflanzenschutz, Munich). Kerntechnik, 9: 302-4(July 1967). (In German).

The operation of the irradiation unit at the Bavarian State Institute of Soil Cultivation, Plant Cultivation, and Plant Protection is discussed. (auth)

36217 OXYGEN CONTROL IS VITAL TO SODIUM-COOLING. Lutz, D. E. (Argonne National Lab., Ill.). Power, 111: No. 8, 108-9(Aug. 1967).

Oxide impurity control procedures for sodium-cooled systems are presented. The two methods described for removing sodium oxides from the bulk sodium are cold trapping and hot trapping. Cold trapping has a high capacity for oxide removal per unit volume since it uses the reduced solubility property of sodium oxides at reduced temperature. Hot trapping employs refractory alloys alloys such as zirconium and titanium at temperatures of 1200 to 1400°F to reduce sodium oxide to pure sodium and to an oxide retained on the refractory alloys. (D.C.C.)

36218 DEVICE FOR MAGNETOHYDRODYNAMIC INVESTIGATIONS OF FREE UNIMMERSED LIQUID METAL JETS. Dorofeev, V. S. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 2, 54-6(1967). (In Russian).

Information is presented on the general scheme, construction, and experience of running a device for the magnetohydrodynamic investigation of a liquid tin jet. (auth)

36219 ACCURATE DE HAAS–VAN ALPHEN PERIODS FOR CALIBRATION OF MAGNETIC FIELDS AT LOW TEMPERATURE. O'Sullivan, W. J.; Schirber, J. E. (Sandia Lab., N. Mex.). Cryogenics, 7: 118-19(Apr. 1967).

A means of calibrating high-field magnets using selected de Haas–van Alphen oscillations in lead, beryllium, tungsten and copper is described. These periods, based on in situ NMR field determinations, provide accurate low temperature calibration aids which are particularly useful for low temperature, high homogeneity pulsed solenoids. (UK)

36220 AUTONOMOUS GENERATOR OF ELECTROMAGNETIC SIGNALS, FED BY A NUCLEAR BATTERY. (to Soc. Saint-Gobain Nucleaire). French Patent 1,379,644. Oct. 19, 1964. Filed June 7, 1963.

A device is described for the generation of electromagnetic pulses, e.g., light pulses, by means of a direct-charging nuclear battery connected with an electric condenser. Two electric schemes are described. (auth)

36221 OFFGAS SAMPLING EQUIPMENT (Engineering Materials). (Richland Operations Office (AEC), Wash.). (CAPE–1629).

8 drawings.

Arrangements for drawing air and other gases from hoods and stacks in various buildings and sampler systems to determine the extent of contamination of the gases with fission products or plutonium are described. (For details see TID-4100 Suppl. 41) (F.S.)

36222 PERIPHERAL COMPRESSOR (Engineering Materials). (Oak Ridge Gaseous Diffusion Plant, Tenn.). (CAPE–1624).

12 drawings.

A peripheral device is described which may be used as a peripheral pump when operating in incompressible flow and a peripheral compressor when operating in compressible flow. The compressor is a low-specific-speed unit with efficiency of 30 to 50%. It is used where power requirements are not of prime importance. The compressor operates satisfactorily without surging or unstable operation with gases having a range of molecular weights of 4 to 400. The operation is stable at all speeds and flows but some limitations at high impeller Mach numbers were encountered. In operation fluid enters at the periphery, passes through a channel at the periphery. Between the suction and discharge is a stripper or block seal that minimizes leakage flow from the high pressure outlet region to the low pressure inlet region. (For details see TID-4100 Suppl. 41) (F.S.)

36223 THERMIONIC DIODE HOUSING EQUIPMENT (Engineering Materials). (Stanford Linear Accelerator Center, Calif.). (CAPE–1630).

3 drawings.

Housing equipment is described for the thermionic diodes used in detecting radiofrequency signals at the Stanford Linear Accelerator. The diodes are used in phasing klystrons with the electron beam and for detecting information coming from the beam position monitors. See CAPE-1503 and 1401. (For details see TID-4100 Suppl. 41) (F.S.)

36224 APPARATUS FOR DISMANTLING AND DECONTAMINATING, NOTABLY FOR CALUTRONS. (to CEA). French Patent 1,314,501. Dec. 3, 1962. Filed Nov. 29, 1961.

The apparatus described for dismantling and decontaminating

calutrons is similar to that described in British Patent 960,751; see NSA 18-27649. (auth)

36225 DIES FOR THE MANUFACTURE OF ARTICLES HAVING CONTOURED SURFACES. (to Nuclear Power Plant Comp. Ltd. A.E.I.-John Thompson Nuclear Energy Comp. Ltd.). French Patent 1,305,138. Aug. 20, 1962. Priority date Nov. 9, 1960, Great Britain.

A die is described for the manufacture of finned tubes which is to be assembled from separate die-plates. Similar to British patent 947.878. (UK)

36226 IMPROVEMENTS RELATING TO GRABS. Warren, Harold Edward (to Fairey Engineering Ltd.). British Patent 1,080,361. Aug 23, 1967. Filed Dec. 12, 1962.

Equipment designed for remote operation in restricted passages such as those in reactor cores for grabbing shapes is described. A cannister-type television camera designed for insertion in elongated tunnels is included. (J.R.D.)

36227 DEVICE FOR SECURING REMOTE-CONTROL MANIPULATORS AGAINST ROTATION. Mas, Roland Georges (to Commissariat a l'Energie Atomique). British Patent 1,080,194. Aug. 23, 1967. Priority date Apr. 23, 1965, France.

The device is comprised of an arm, a fore-arm, and a wrist which are pivotally coupled with one degree of freedom in such a manner as to permit their displacements in the same vertical plane. A grab is included which is mounted so as to be capable of rotation about the wrist. A control motor set is also included to drive the arm in rotation and a clamp operated by the grab to immobilize the arm. (J.R.D.)

36228 IMPROVEMENTS RELATING TO GRABS. Warren, Harold Edward (to Fairey Engineering Ltd.). British Patent 1,080,362. Aug. 23, 1967. Filed Feb. 8, 1963.

Devices for use in grabbing lengths of cable in restricted passages are described. These devices are useful in channels for fuel elements and control rods in reactor cores. (J.R.D.)

Heat Transfer and Fluid Flow

Refer also to abstracts 36781, 36789, 37259, and 38862.

36229 (BNL-11532) EFFECT OF SLIP RATIO ON THE CRUCIAL BOILING LENGTH IN TWO-PHASE INSTABILITY. Shotkin, Louis M. (Brookhaven National Lab., Upton, N. Y.). June 1967. 16p. (CONF-670912-2). Dep. CFSTI.

From Symposium on the Dynamics of Two Phase Flow, Eindhoven, Netherlands.

The crucial boiling length, l_C, for a single channel is that position of the boiling boundary where the channel is least stable, or where the ratio of heat input to coolant flow rate, Q_s/G_s, is a minimum. The analytical relation between Q_s/G_s and the rest of the channel parameters depends very much on the theoretical model used and, in particular, on the empirical form of the slip ratio. A spatially-averaged model was used to compute l_C [or rather $(Q_s/G_s)_{min}$] and to compare it with experimental results from several laboratories in the $Q_s/G_s-\delta H$ plane. In doing this two empirical forms for the slip ratio were tested. (auth)

36230 (KAPL-M-6721) RVIB, A COMPUTER PROGRAM FOR FLOW INDUCED SELF EXCITED VIBRATION OF A BLADE SUSPENDED IN A FLOW CHANNEL. Kennison, R. G. (Knolls Atomic Power Lab., Schenectady, N. Y.). June 12, 1967. 24p. Dep. CFSTI.

A computer program is presented for the analysis of flow induced, self excited vibration of a blade suspended in a flow channel. This program may be applied to blade type control rods and other similar structures. The program is written for the CDC 6600 computer and does not require specialized subroutines. The output identifies all regions of static and dynamic instability and defines the flow-frequency boundary between the damped and divergent vibration regions. The program is based on the analyses reported in KAPL-M-6559 (RGK-20), June 3, 1966, Theoretical Analysis of Flow-Induced Vibration of a Blade Suspended in a Flow Channel., May 26, 1966, R. G. Kennison and D. R. Miller. (auth)

36231 (ORNL-P-3188) TECHNIQUES FOR STABILIZING LIQUID METAL POOL BOILING. MacPherson, R. E. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 19p. (CONF-670916-1). Dep. CFSTI.

For Presentation at International Conference on the Safety of Fast Reactors, Aix en Provence, France.

Liquid-metal-cooled reactor projects at the Oak Ridge National Laboratory have required the operation of potassium pool boilers for materials compatibility tests and for performance and endurance tests of components. In many diverse facilities, problems with superheating of liquid metal have been encountered. To avoid these problems, special operating techniques and mechanical devices have been developed. Vapor traps in the form of metal sleeves mechanically attached to heat transmitting surfaces in the boiler have been effective in stabilizing boiling. Independently heated devices designed to discharge vapor into the boiler pool serve to initiate the boiling process smoothly. Related experience has come from tests of the cavitation characteristics of liquid metal pumps, wherein the presence or absence of inert gas has affected cavitation inception, a form of boiling. (auth)

36232 (ORNL-P-3190) EXPERIMENT EMPLOYING ULTRASONIC ENERGY TO PROMOTE BOILING IN LIQUID METALS. Yarosh, M. M. (Oak Ridge National Lab., Tenn.). [1967]. Contract W-7405-eng-26. 29p. (CONF-670916-2). Dep. CFSTI.

From International Conference on the Safety of Fast Reactors, Aix en Provence, France.

The tendency for liquid metals such as sodium and potassium to undergo substantial liquid superheating and subsequent explosive boiling has been demonstrated. An experiment was conducted employing ultrasonic energy excitation to initiate and maintain stable boiling in potassium under conditions that normally produced liquid superheating and unstable, explosive boiling. Unstable boiling is characterized by large and erratic temperature differences between the temperatures of the liquid and vapor. These temperature differences were significantly reduced or eliminated upon excitation of the ultrasonic probe. The tendency toward liquid superheating was substantially eliminated under many operating conditions. (auth)

36233 (RHEL/R-145) HEAT TRANSFER THROUGH LOW PRESSURE HELIUM GAS AT TEMPERATURES BELOW 4.2°K. Pickles, D. C.; Colyer, B. (Rutherford High Energy Lab., Chilton (England)). Mar. 1967. 9p. Dep. CFSTI. UK 3s.

Experiments on heat transfer through low-pressure helium gas at liquid helium temperatures were performed. The experimental method is described and the results are discussed. It is shown that heat transfer is primarily by conduction. (auth)

36234 (SAN-650-4) ORGANIC RANKINE CYCLE FEASIBILITY DEMONSTRATION PROGRAM. Quarterly Report No. 4, January 1-March 31, 1967. (Philco-Ford Corp., Newport Beach, Calif. Aeronutronic Div.). Apr. 15, 1967. Contract AT(04-3)-650. 53p. Dep. CFSTI.

Development of an organic Rankine cycle power conversion system capable of long operation in space is described. The organic working fluid to be evaluated is monoisopropylbiphenyl (MIPB). The program includes fluid properties evaluation, bearing development, boiler development, and power system design studies. In evaluation of MIPB, three simulated power conversion loops will be operated for 5000 hrs. The loops are sized to correspond to the operation of a 1.5 kW(e) power conversion system having a boiler exit temperature of 650°F and a condenser pressure of 1 psia. The loops consist of a forced circulation boiler, regenerator, condenser, turbine-motor driven multipumps, controls, and instrumentation. Periodic maintenance is permitted, provided the hermetic integrity is not affected. A hydrogen diffusion unit was designed to remove light hydrocarbon gases and hydrogen from the noncondensables which may build up in the loop as a result of thermal decomposition of the working fluid. Plans for analysis of the loop fluid samples are reported and the test loop status is reviewed. Results of component tests are included. Rolling-contact and fluid-film radial bearings lubricated with the process fluid are being evaluated. The boiler test rig design and preliminary operating considerations are described. Endurance runs of 1000 hr and 5000 hr are planned. (F.S.)

36235 (SAN-650-5) ORGANIC RANKINE CYCLE FEASIBILITY DEMONSTRATION PROGRAM. Quarterly Report No. 5, April 1-July 17, 1967. (Philco-Ford Corp., Newport Beach, Calif. Aeronutronic Div.). Contract AT(04-3)-650. 32p. Dep. CFSTI.

The development of the technology in applying monoisopropylbiphenyl (MIPB) as a working fluid in an organic Rankine cycle power conversion system capable of long duration operation in a space environment is described. The program consists of four tasks: fluid property evaluation, bearing development, once-through boiler operation, and the design of the power system. In the evaluation of the MIPB working fluid, three simulated power conversion loops are sized to correspond to the operating conditions of a 1.5 kW(e) conversion system having a boiler exit temperature of 650°F and a condenser pressure of 1 psia. Loops to be operated up to 5000 hrs, consist of forced circulation boilers with separators, regenerators, condensers, turbine-motor driven multipumps, controls, and instrumentation. The loops are essentially hermetic, unmonitored and continuous operating. The objectives of the bearing development task are the analytical and exper-

imental evaluation of sleeve-type and rolling contact journal and thrust bearings, screening various bearing systems, lubricity of the working fluid, and measuring properties such as viscosity and surface tension. Once-through boiler operation will provide data for design and performance comparisons with recirculation boiler operation. A complete space power unit will be designed using data obtained. The first operations on the 1000-hr endurance test, multipump, and the 5000 hr test loop progress is described. In the 1000 hr test, it appears that the MIPB degradation rate presents no serious engineering problems for significantly longer duration runs. Initial checkout tests of the multipump indicate performance within design requirements with undetectable vibration at 8000 rpm. In order to test the bearing design, a turbine-alternator is used to simulate accurately the mass distribution of an actual wheel turbine, alternator bearing and shaft rotating assembly. Turbine parameters are given. (F.S.)

36236 (SAN-651-33) ORGANIC RANKINE CYCLE TECHNOLOGY PROGRAM. Quarterly Progress Report No. 5, April 1–July 1, 1967. Adam, A. Warren (Sundstrand Aviation-Rockford, Ill.). July 14, 1967. Contract AT(04-3)-651. 63p. Dep. CFSTI.

Biphenyl and the eutectic mixture of biphenyl and phenyl ether are being evaluated for use as working fluids in organic Rankine Power Cycle conversion systems for extended operation in space. The program includes studies of pyrolytic degradation of the biphenyl and the eutectic mixture; performance and stability of nonrolling contact and rolling contact bearings operating in biphenyl; evaluation of small high-speed pumps operating at high suction specific speeds with biphenyl; and the investigation of the heat transfer, stability, and performance of organic working fluid boilers. Four loops have operated successfully; physical properties show no changes; a few low boiling contaminants have been detected but benzene and terphenyls were not detected. Bearing and bearing test rig design specifications have been approved. Centrifugal pumps, a pump test rig, and test loop designs were completed. Design of the boiler test loop is complete. (F.S.)

36237 (TID-23937) A STUDY OF THE OPERATING CHARACTERISTICS OF THE HEAT PIPE. Progress Report, January 1–June 30, 1967. Ferrell, J. K.; Carnesale, A. (North Carolina State Univ., Raleigh). July 1, 1967. Contract AT(40-1)-3411. 29p. Dep. CFSTI.

Work performed from January 1, 1967, through June 30, 1967, on the following is reported: operation of a stainless steel heat pipe at increased power levels and with several different wick bead sizes, heat pipe analysis, investigation of heat transfer through porous media, design of a controlled environment heat pipe experiment, and investigation of the fundamental aspects of capillarity. (auth)

36238 HEAT TRANSFER FROM HIGH-TEMPERATURE SPHERES TO LIQUID SODIUM. Witte, L. C. (Argonne National Lab., Ill.); Baker, L. Jr.; Haworth, D. R. Trans. Amer. Nucl. Soc., 10: 351-2(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36239 TURBULENT TEMPERATURE FLUCTUATIONS IN FLOWING SODIUM–POTASSIUM. Hochreiter, L. E.; Sesonske, Alexander (Purdue Univ., Lafayette, Ind.). Trans. Amer. Nucl. Soc., 10: 353-4(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36240 BEHAVIOR OF AIR BUBBLES IN CIRCULAR TUBES. Rosen, Morris; Shuster, W. W. (Rensselaer Polytechnic Inst., Troy, N. Y.). Trans. Amer. Nucl. Soc., 10: 357-9(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36241 NEW THERMODYNAMIC INTERPRETATION OF THE BOILING CRISIS. Basso, Giuseppe (CNEN, Rome). Trans. Amer. Nucl. Soc., 10: 360-1(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36242 HIGH-QUALITY TWO-PHASE CHOKED FLOW. Fauske, Hans K. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 361(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36243 INVESTIGATION OF THE EFFECT OF VIBRATIONS ON HEAT TRANSFER IN PRESSURIZED WATER SYSTEMS. Jordan, E. D.; Steffens, J. (Catholic Univ. of America, Washington, D. C.). Trans. Amer. Nucl. Soc., 10: 361-2(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36244 EXPERIMENTAL INVESTIGATION OF A VAPOR-DRIVEN TWO-PHASE VORTEX. Lafferty, J. F. (Univ. of Kentucky, Lexington); Hammitt, F. G. Trans. Amer. Nucl. Soc., 10: 362-3(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36245 INFLUENCE OF GEOMETRY ON CRITICAL HEAT FLUX OF SUBCOOLED BOILING. Cumo, Maurizio; Palmieri, Angelo (CNEN, Casaccia, Italy). Calore, 37: 456-73(1966). (In Italian).

The influence of the cooling channel's geometry on the critical heat flux in conditions of subcooled boiling was determined with an organic coolant (orthoterphenyl) and with tubular test sections. The experimental results showed that with hydraulic dia values in nuclear reactors there is an appreciable increase of the critical heat flux with smaller dia and that this increase should be taken into consideration (from D = 10 to 5 mm, it is, on the average, over 35%). The channel length does not influence the critical flux for extensions of more than 30 dia. A dimensional analysis shows the importance of the dependency of the critical heat flux on the geometrical dimensions. (auth)

36246 THERMAL STRESSES IN LONG HOLLOW AELOTROPIC CYLINDERS SUBJECTED TO γ-RAY HEATING. Bagchi, Madhab Chandra (Surendranath Coll., Calcutta). J. Sci. Eng. Res., Indian Inst. Technol., Kharagpur, 9: 171-8(Jan. 1965).

Increasing attention has been paid recently to the determination of thermal stresses in isotropic cylinders subjected to internal heat generation due to axisymmetric radiation. The problem of ascertaining thermal stresses in isotropic cylinders, the outer curved surface of which is perfectly insulated, has been considered earlier, the source of generation of heat being due to γ radiation, and a solution was sought to the corresponding problem for transversely isotropic material. The exact solution contains an exponential integral function. After tabular solutions of the function were found, the numerical calculations were carried out. The circumferential stress on the boundary of the inner wall was found for Mg. The variations of the thermal stress were considered in terms of the variations of the ratio of wall thickness. (BBB)

36247 HEAT TRANSFER: LOS ANGELES. Eighth National Heat Transfer Conference, Los Angeles, August 8–11, 1965. Knudsen, James G. (ed.). Chem. Eng. Progr., Symp. Ser., 62: No. 64, 1-274(1966). (CONF-650812).

Separate abstracts were prepared for six of the thirty-two papers presented. The remaining papers contain information on developments in heat transfer including processes involving changes of phase, fundamental aspects of nucleate boiling, film boiling, condensation processes, fouling of heat transfer surfaces, mathematical solutions of heat transfer problems, heat transfer in space application, and equipment performance. (F.S.)

For abstracts of individual papers see: 36248–36253.

36248 INFLUENCE OF AXIALLY NONUNIFORM HEAT FLUX ON DNB. Tong, L. S.; Currin, H. B.; Larsen, P. S.; Smith, O. G. (Westinghouse Electric Corp., Pittsburgh). Chem. Eng. Progr., Symp. Ser., 62: No. 64, 35-40(1966).

The influence of axially nonuniform heat flux on departure from nucleate boiling (DNB) has been analyzed. A correction factor has been developed whereby DNB for a nonuniform heat flux can be predicted from the existing uniform DNB correlations under identical local DNB conditions. The correction factor is a function of heat flux shape, subcooled boiling length upstream from point of DNB, local quality, and mass velocity. Existing nonuniform heat flux DNB data were corrected by the use of this factor, and comparison with corresponding uniform flux data shows good agreement. (auth)

36249 CRITICAL HEAT FLUX FOR BOILING LIQUID METAL SYSTEMS. Caswell, Bruce F.; Balzhiser, Richard E. (Univ. of Michigan, Ann Arbor). Chem. Eng. Progr., Symp. Ser., 62: No. 64, 41-6(1966).

The critical heat flux was measured for water, sodium, and rubidium with $\frac{3}{8}$-in. diameter horizontal cylindrical heaters. These data and those of other investigators were correlated empirically. Two correlations were presented: one for liquid metals only, and the other as a general relationship for both metallic and nonmetallic fluids. (auth)

36250 LIQUID DROP MODEL VIBRATIONS AND SIMULATED FISSION. Schoessow, G. J. (Univ. of Florida, Gainesville); Baumeister, K. J. Chem. Eng. Progr., Symp. Ser., 62: No. 64, 47-51(1966).

Liquid water and nitrogen drops vibrating in their natural frequencies above a hot plate on a cushion of vapor are compared with theory with good correlation. High-speed photographic techniques were used to record the vibration and the frequency. Liquid drop model vibrations and their relation to simulated fission of the atomic nucleus are also experimentally demonstrated. (auth)

36251 AN EXPERIMENTAL STUDY OF TRANSIENT HEAT TRANSFER TO LIQUIDS IN CYLINDRICAL ENCLOSURES. Evans, L. B. (Massachusetts Inst. of Tech., Cambridge); Stefany, N. E. Chem. Eng. Progr., Symp. Ser., 62: No. 64, 209-15(1966).

An experimental study was made of transient heat transfer to liquids in cylindrical enclosures subjected to a step-change in the wall temperature. Measurements were made of the mixed-mean temperature of liquid in the enclosure, following a step in wall temperature, by observing the net thermal contraction or expansion of enclosed fluid. This technique avoided interference with the natural convection flow. Studies were made with 2- and 2.5-in. diameter cylinders, oriented both vertically and horizontally, whose L/D ratio ranged from 0.75 to 2.0. By using water, n-butanol, methanol, and water-glycerine mixtures, a range of Rayleigh numbers (based on initial temperature difference) spanning four orders of magnitude was investigated. Data were obtained for both heating and cooling. The heat transfer coefficient was found to be constant over most of the transient period. A correlation representing all of the data was obtained with Nusselt number proportional to the one-fourth power of the Rayleigh number. An alternate form of the correlation was developed to determine mixed-mean temperature as a function of time. (auth)

36252 SYSTEMATIC CORRELATION FOR TWO-PHASE PRESSURE DROP. Baroczy, C. J. (Atomics International, Canoga Park, Calif.). Chem. Eng. Progr., Symp. Ser., 62: No. 64, 232-49(1966).

A correlation which considers fluid properties, mixture quality, and mass velocity is described for the prediction of two-phase friction pressure drop for both single- and two-component flow. The correlation is based on data for steam, water–air, and mercury–nitrogen for a wide range of quality and mass velocity. The two-phase friction multiplier is shown to be a function of liquid to gas viscosity and density ratios (a property index), mixture quality, and mass velocity for the following ranges: property index, critical point to five decades below, quality 0.1 to 100%, mass velocity 0.25×10^6 to 3×10^6 lb/(hr) (sq ft). Comparison of the correlation with additional data for water–air, steam, sodium potassium–nitrogen, kerosene–air, diesel oil–air, and potassium, showed good agreement. (auth)

36253 THERMAL CONDUCTIVITY OF HYDROGEN FROM 2,000° TO 4,700°F. Israel, S. L. (United Nuclear Corp., White Plains, N. Y.); Hawkins, T. D.; Salter, R. T.; Hyman, S. C. Chem. Eng. Progr., Symp. Ser., 62: No. 64, 258-64(1966).

The thermal conductivity of hydrogen at 2,000 to 4,700°F and 15 to 150 lb/sq in. abs was determined from the measured effective conductivity of porous tungsten specimens filled with pressurized hydrogen. Effective conductivities were determined from temperature measurements on the upper flat surface of the right circular cylindrical porous specimen heated by high-frequency induction currents. The values of effective conductivities were calculated by equating the axial centerline heat flux at the surface of the specimen, which was determined from the solution of the heat conduction boundary-value problem, with the radiation and thermal convection heat losses at the same point. A truncated-sphere model of the porous structure was used to relate the gas conductivity to the effective conductivity of the gas-filled specimen. The thermal conductivity of hydrogen, determined by the above method, compares reasonably well with existing experimental and theoretical work. The conductivity increases with increasing temperatures above 3,000°F. (auth)

36254 HEAT TRANSMISSION TUBE. (to Sulzer Freres, S. A.). French Patent 1,403,498. May 5, 1965. Priority date Sept. 6, 1963, Switzerland.

A heat transfer tube, e.g., a cylindrical can for a fuel element, is provided with longitudinal fins, intersected by helical, trapezoidal channels presenting an inclination of 70 to 85°. These channels impart a gyratory motion to a longitudinally flowing coolant. (auth)

36255 HEAT EXCHANGER TUBES WITH GROOVED PROFILE. Huet, A. French Patent 1,195,426. May 19, 1959. Filed Apr. 25, 1958.

Heat exchanger tubes with a circular or lenticular cross-section and provided either with trapezoidal longitudinal fins or with circumferential rows of pyramidal protuberances are described. The fins and protuberances have a height of 1 mm. The tubes are useful as fuel element cans. (auth)

36256 HEAT TRANSFER SURFACES. (to United Kingdom Atomic Energy Authority). French Patent 1,369,174. June 29, 1964. Priority date Sept. 14, 1962, Great Britain.

To promote turbulence of the coolant, a sleeve, consisting of a metal network, is slipped over a plain cylindrical heat transfer tube, e.g., a fuel element can. (auth)

36257 IMPROVEMENTS IN HEAT EXCHANGERS. (to Babcock and Wilcox Co.). French Patent 1,391,219. Jan. 25, 1965. Priority date Feb. 28, 1963, United States.

A vapor generator is described in which a liquid metal can be used as the heating medium. Adequate safety in the event of interaction of the heated liquid metal and water is provided. All of the areas containing the liquid metal may be drained, vented, and cleaned. No areas of flow stagnation in either the water or the liquid metal flow paths are present. The heat exchanger has a vertically elongated cylindrical pressure vessel in which a container is placed. The container is spaced from the walls of the vessel, forming a continuous gas space which completely envelops the container. A bundle of heat exchange tubes is arranged within the container for coolant flowthrough. The container may have a relatively thin wall and is arranged so that the flow of heat exchange liquid is confined within the container, so that it does not come into contact with the heavier walls of the pressure vessel. The inert gas in the gas space, which completely envelops the container, provides a cushioning effect for pressure surges. (auth)

Isotope Technology

Refer also to abstracts 35987, 36075, 36086, 36127–36139, 36141, 36142, 36149, 36153–36158, 36205, 36206, 36782, 36790, 37584, 38608, and 38826.

36258 (EUR-3498.e) NON-FUEL APPLICATIONS OF alpha-EMITTING NUCLIDES. Kool, J. (European Atomic Energy Community). Aug. 1967. 45p. Dep.

Data concerning the application of heavy element α-active isotopes, other than their application as a new nuclear fuel, are reviewed. An attempt was made to extrapolate present data and trends, both from a technological as well as from an overall economic point of view. Attention was drawn to a number of problems that urgently require further study. (auth)

36259 (N-67-20163) DEVELOPMENT OF THE MANNED ORBITAL RESEARCH LABORATORY (MORL) SYSTEM UTILIZATION POTENTIAL. TASK AREA IV: MORL SYSTEM IMPROVEMENT STUDY, BOOK 1. Allen, J. L. (Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.). Dec. 1965. Contract NAS1-3612. 325p. (NASA-CR-66288; SM-48815). CFSTI.

Baseline changes in the configuration and interior design are described, and results of improvement studies for structures, electrical power, logistics, and vehicle performance are presented. Mission analysis changes are also discussed, problem areas chargeable to the alternate missions are outlined, and alternate concepts and studies for future MORL research are identified. The solar cell/battery and the ^{238}Pu isotope Brayton cycle (PBC) system are compared. The recommendation is made that a PBC system of 11 kW nominal capacity be used as the baseline power system for the MORL. Payload requirements and laboratory weight are assessed, and the resulting discretionary payload is derived. Analytical data are also included on axial handling and stowage system; solar cell panel shadowing; electrical loads; and isotope costs. Flow charts present the technological requirements of a solar cell/battery system that could be implemented in support of the MORL development. (STAR)

36260 (N-67-20166) REPORT ON THE DEVELOPMENT OF THE MANNED ORBITAL RESEARCH LABORATORY (MORL) SYSTEM UTILIZATION POTENTIAL. TASK AREA IV: MORL SYSTEM IMPROVEMENT STUDY, BOOK 5, VOLUME 1. Pisciotta, A. (Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.). Jan. 1966. Contract NAS1-3612. 307p. (NASA-CR-66292; SM-48819A). CFSTI.

The MORL Propulsion/Reaction Control System (P/RCS) study consisted of (1) an advance P/RCS study, (2) a baseline system evaluation study, and (3) a systems integration study. The advance P/RCS study consisted of an evaluation of advanced chemical, electrical, and radioisotope thermal propulsion system concepts for application to the MORL mission. A Resistojet and a radioisotope thrustor system were selected for preliminary design integration into the MORL system. The baseline system evaluation study consisted of a review of the components of the P/RCS baseline system to establish those components of the system requiring updating of the design as a result of advances in technology, related subsystem design changes resulting from the MORL responsiveness analysis, and the change in the anticipated MORL launch data to the 1970 time period. The systems integration study utilized the results of the two previous studies to integrate the preliminary designs of both the updated liquid bipropellant system and the two advanced systems with the MORL mission and operations. (STAR)

36261 (ORNL-TM-1691(Del.)) BRAYTON-CYCLE RADIOISOTOPE HEAT SOURCE DESIGN STUDY, PHASE I (CONCEPTUAL DESIGN) REPORT. Robinson, R. A.; Beaver, R. J.; Burton, D. W.; Chapman, T. G.; Craven, C. W. Jr.; Ewing, S. T.; Miller, A. J.; Nichols, J. P.; Stephenson, R. L. (Oak Ridge National Lab., Tenn.). Aug. 1967. Contract W-7405-eng-26. 237p. (NASA-CR-72090). Dep. CFSTI.

Designs were prepared for $^{238}PuO_2$, $^{244}Cm_2O_3$, and $^{147}Pm_2O_3$ radioisotope heat source systems that will provide 25 kW of thermal power to a Brayton-cycle power conversion system for space applications. The designs for all three fuels show primary containment provided by multilayered fuel capsules, with tantalum-based alloy T-222 as the principal stress-bearing layer and platinum as the outer corrosion-resistant layer. All the designs show the assembly of fuel capsules contained within a single reentry body for protection against reentry heating and subsequent impact in the event of a mission abort. The designs are based on containing the radioisotope fuel within the fuel capsules for a period of time equal to ten half lives or longer of the radioisotope. Estimated system weights based on the conceptual designs range from approximately 3000 to 25,000 lb, depending on the fuel and design concept. (auth)

36262 (ORNL-TM-1829) BRAYTON-CYCLE RADIOISOTOPE HEAT-SOURCE DESIGN STUDY, PHASE II (PRELIMINARY DESIGN) REPORT. Robinson, R. A.; Chapman, T. G.; Ewing, S. T.; Miller, A. J.; Nichols, J. P. (Oak Ridge National Lab., Tenn.). Aug. 1967. Contract W-7405-eng-26. 137p. (NASA-CR-72151). Dep. CFSTI.

A preliminary design was prepared for a 25-kW(th) $^{238}PuO_2$ heat source that can be coupled with a Brayton-cycle power-conversion system for use in space. Primary containment is provided by multilayered fuel capsules, with tantalum-based alloy T-111 as the principal stress-bearing layer and platinum as the outer corrosion-resistant layer. The multipurpose mission module specified by NASA is used as the vehicle configuration for integration studies. The assembly of fuel capsules is contained within a single reentry body for protection against reentry heating and subsequent impact in the event of a mission abort. The fuel capsule complies with the design criterion of no more than 1% creep in five years of service. The safety guideline that the radioisotope fuel can be contained within the fuel capsules for a period of ten half lives of ^{238}Pu or longer is a goal toward which the capsule design is directed. The weight of the heat-source system, including the reentry body, fuel, heat exchanger, and shield is 2670 lb. Preliminary designs are described of facilities for fueling and assembling capsules, shipment of capsules to launch site, and handling at the launch site. Since the heat-source design is based partly on near-future materials technology and on extrapolation from present aerodynamic data, identification is made of areas where further investigations will have to be carried out to test the validity of the design. (auth)

36263 (ORNL-TM-1940(Pt.1)) SELECTED ABSTRACTS OF NON-U. S. LITERATURE ON PRODUCTION AND INDUSTRIAL USES OF RADIOISOTOPES. From NSA, January–June 1967. Gerrard, Martha; Baker, P. S. (Oak Ridge National Lab., Tenn.). Aug. 1967. Contract W-7405-eng-26. 63p. Dep. CFSTI.

More than 750 abstracts of non-U.S. publications on production and industrial uses of radioisotopes and radiation, selected from the January–June 1967 issues of Nuclear Science Abstracts, are presented. (auth)

36264 (WANL-3800-001) PHASE 1 QUARTERLY PROGRESS REPORT, MARCH 1–MAY 31, 1967. Cerni, S. (Westinghouse Electric Corp., Pittsburgh Pa. Astronuclear Lab.). June 9, 1967. Contract AT(30-1)-3800. 226p. (WANL-PR-(SS)-004). Dep. CFSTI.

A 60 watt(e) system optimization study considering size, weight and cost was completed for SNAP 23A of an Advanced Terrestrial Radioisotope Power System. It was found that system weight is minimum at a system diameter of approximately 22 in. The cost, however, continues to decrease with increasing dia over the range of interest. A system dia of 24 in. was selected for the first mock-up system. This involves a slight compromise in weight but yields the lowest cost within the design objective of a 24 in. envelope. Stress analysis of the fuel capsule was completed. The capsule walls and end caps were sized to withstand the hydrostatic pressure associated with accidental sea burial to a depth of 20,000 feet. The fuel pellet dia for the 60 watt(e) system was selected as 4 in., based on trade-offs in system optimization and extension in ORNL development. This is the largest capsule considered to date. The design of the first mock-up system, 60 watt(e), was completed. This system will use an electically heated capsule and a thermoelectric converter supplied by the 3M Company. Drawings have either been released or will be released shortly for procurement of system hardware. Based on delivery estimates, it appears that there will be a delay in the test date unless order placement and necessary approvals are expedited at an earlier time. (auth)

36265 (BNL-tr-142) SOME TECHNICAL AND ECONOMIC ASPECTS OF RADIOCATALYSIS IN APPLICATION TO FUEL CELLS. Henry, J. F.; Gevenois, E. (Societe d'Etudes, de Recherches et d'Applications pour l'Industrie, Brussels (Belgium)). Translated for Brookhaven National Lab., Upton, N. Y., from a report. 33p. Dep. CFSTI. JCL $3.60 fs, $1.19 mf.

In a study of the technical and economic aspects of radiocatalysis in fuel cells it was found that the cost of energy produced by an activated cell is higher than the cost of energy produced by an unactivated cell. When the terminal voltage of the cells is fixed, an activated cell may be more economical than an unactivated cell provided the fixed voltage is above a certain limit which is a function of the characteristic cell parameters. This conclusion holds in particular for cells containing ^{14}C and ^{60}Co. When the current density is fixed, it appears that an activated cell is more economical than an unactivated cell provided the current density is above a limit determined by the parameter characterizing the cells. In general, cell activation permits reduction of volume and weight for equal power provided the radiation shielding means are not too great. Under certain conditions (high terminal voltage or current density), it is possible in principle to build cells that are more compact, lighter and more economical by using radioelements incorporated in the cell. Results show that in some cases, and for the cells considered, introduction of radioelements is technically and economically advantageous. For military and space applications substantial weight reduction and compactness gains due to activation are especially desirable. This applies particularly to ^{14}C or ^{63}Ni activation, which does not present safety problems. (auth)

36266 PREPARATION OF VERY HIGH-SPECIFIC-ACTIVITY ^{60}Co AND ^{192}Ir. Case, F. N.; Acree, E. H. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 51(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36267 ISOTOPIC POWER IN EUROPE. II. Morse, J. G. (Martin Marietta Corp., Denver, Colo.). Trans. Amer. Nucl. Soc., 10: 69-70(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36268 ^{60}Co HEAT SOURCE ENCAPSULATION. Angerman, C. L.; Faraci, J. P.; King, F. D. R.; Symonds, A. E. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc., 10: 70(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36269 USE OF NUCLEAR TECHNIQUES IN SNOW AND RELATED WATERSHED MANAGEMENT. Smith, James L. (Dept. of Agriculture, Berkeley, Calif.). Trans. Amer. Nucl. Soc., 10: 78(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36270 USE OF RADIOISOTOPES FOR LETTUCE HARVESTING. Garrett, Roger E.; Talley, Wilson K. (Univ. of California, Davis). Trans. Amer. Nucl. Soc., 10: 41(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36271 ^{238}Pu FROM THE SNAP-9A BURNUP. Krey, Philip W. (Atomic Energy Commission, New York, N. Y.). Trans. Amer. Nucl. Soc., 10: 1(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36272 EVALUATION OF INTERNAL-DOSE PROBABILITIES BY A MONTE CARLO TECHNIQUE. Anderson, D. C.; Ruwe, D. M.; Spamer, A. M. (Martin Marietta Corp., Baltimore). Trans. Amer. Nucl. Soc., 10: 5(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36273 PROBABILITY OF INJURY FROM RANDOM REENTRY OF A NUCLEAR SATELLITE. Easton, C. R.; Langley, R. W. (Douglas Aircraft Co., Inc., Santa Monica, Calif.). Trans. Amer. Nucl. Soc., 10: 6-7(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36274 HEAT-TRANSFER MODES FOR A CYLINDRICAL SOURCE EMBEDDED IN LIQUID-FILLED POROUS MEDIA. Schrock, V. E. (Univ. of California, Berkeley). Trans. Amer. Nucl. Soc., 10: 7(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36275 SPACE ISOTOPE POWER PROGRAM. Clark, Arthur J. Jr. (Sandia Corp., Albuquerque, N. Mex.). Trans. Amer. Nucl. Soc., 10: 8(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36276 OPTIMAL COSTS OF ISOTOPES. Eckhoff, N. D.; Fan, L. T.; Kimel, W. R. (Kansas State Univ., Manhattan). Nucl. Instrum. Methods, 53: 181–4(1967).

Minimization of costs associated with the production of radioactive isotopes is performed through the utilization of Pontryagin's maximum principle. A development of a maximum principle algorithm using both a quadratic form and a more general form as the objective function is given. Costs for several non-optimal irradiation policies are compared to the costs for the optimal policy for the production of several different radioactive isotopes. Results of this work can be especially significant for nuclear facilities which produce isotopes for sale or those for which neutron flux level is available at a premium because of fuel burnup or other considerations. (auth)

36277 THE ^{85}Kr BREMSSTRAHLUNG APPLIED FOR EXTENDING THE RANGE OF THICKNESS MEASUREMENTS. Boehme, G. (VEB Vakutronik, Dresden). Isotopenpraxis, 3: 124-7(Apr. 1967). (In German).

The construction of the ^{85}Kr bremsstrahlung sources used is described. Some applications for the measurement of the thickness of heavy-metal and aluminium strips are given, and the measuring ranges obtained from these studies are discussed with regard to the automatic mass per unit area gage VA-T-75. (auth)

36278 NEUTRON ACTIVATION METHOD FOR MEASURING THE WEAR OF ELECTRIC TRAIN GEAR WHEELS. Pelekis, Z. E.; Pelekis, L. L.; Smirnov, V. I.; Taure, I. Ya. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 2, 121-6(1967). (In Russian).

A neutron activation method for determining the wear of electric train gear wheels was developed and verified in working conditions. The weight of the wear particles in the lubricant is determined after the irradiation in an atomic reactor of ^{56}Mn from the γ-spectrum. The sensitivity of the method has been found to be 0.1 mg steel in 1g liquid lubricant. (auth)

36279 ELECTRODIALYTICAL DEPOSITION OF HYDROXIDES OF THE RARE EARTH ELEMENTS ON ANION EXCHANGE MEMBRANES. Roemer, J.; Schwabe, K. (Zentralinstitut fuer Kernphysik, Rossendorf, Ger.). Isotopenpraxis, 3: 127-31(Apr. 1967). (In German).

Electrodialytical depositions of hydroxides of the rare earth elements (RE) on anion exchange membranes (AEM) are good beta-sources for nuclear-spectroscopic investigations. The following arrangement + HNO_3, RE^{+++}/AEM/NaOH – was employed for the production of the sources. The influence of several factors was investigated. The quality of sources produced was judged nuclear-spectroscopically by spectra of ^{161}Tb. (auth)

36280 INDUSTRIAL ISOTOPE TECHNOLOGY IN JAPAN. Erwall, L. G. (Isoptekniska Laboratoriet, Stockholm). Tek. Vetensk. Forsk., 3: 72–4(1967). (In Swedish).

A survey is given of the various applications of radioisotopes in industry, tracer methods in metallurgy and iron production, activation analysis applied to the mapping of high mercury contents in fish and rice, and radiochemistry for research on radiation induced reactions and development of industrial processes. Information on capital investments and volume of activities is summarized. (SWED)

36281 RELIABILITY AND CIRCUIT ANALYSIS OF THERMOPILES WITH REDUNDANT ELEMENTS. Toomb, D. S. Jr. (Aerojet-General Nucleonics, San Ramon, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 4, 17-28 (Aug. 1967).

Thermoelectric generators are gaining increased usage in connection with low-power sources for remote areas and for oceanographic and space applications. These applications require a terminal voltage which must be supplied by connecting many thermocouple elements in series. The reliability of such an array of series-connected thermocouples is determined by the inherent reliability of the individual thermoelectric elements and decreases rapidly as the number of elements is increased; however, appreciable increases in thermopile reliability can result from the use of active redundant elements in parallel. The reliability of the simple series, parallel/series and series/parallel thermocouple interconnection modes are analyzed and compared. The results are presented as a function of individual couple reliability and the number of couples determining the no-load potential. The series/parallel connection scheme is shown to yield the highest reliability, and an array so connected can provide a relatively constant power and voltage output despite the failure of several elements. (auth)

36282 LIGHTING APPARATUS. (to Lenze K.G.). French Patent 1,198,757. June 15, 1959. Priority date Feb. 11, 1957, Germany.

Spherical and oblong light sources are described in which luminescent material is brought to luminescence by means of a separate radioactive source. Preferably the source contains nuclear reactor waste, a radiation converter (e.g., Hg vapor) is applied between the radioactive source and the luminescent material. (auth)

36283 LUMINOUS SOURCE WITH RADIOACTIVE RADIATION SOURCE. (to Trilux-Lenze K.G.). French Patent 1,336,500. July 22, 1963. Priority date Sept. 27, 1961, Germany.

A luminescent light source in which the activating agent is a gamma source is described. The luminescent material is carried by supporting means which are capable of converting gamma radiation into a softer radiation (e.g., ultraviolet light) by means of the Compton effect, this softer radiation provoking the luminescence. 9 embodiments are described. (auth)

36284 LUMINESCENT BOX WITH HINGED SHIELDING COVER. (to Phillips and Pain-Vermorel). French Patent 1,237,849. June 27, 1960. Filed June 24, 1959.

A portable light source is described which comprises shielded housing, a transparent window in the wall of the housing, a mixture of a luminescent material and a radioactive material in the interior of the housing, and a hinged shielding cover that can be fitted over the window when the device is not in use. (auth)

36285 IMPROVEMENTS IN LUMINOUS SOURCES. (to Saunders Roe and Nuclear Enterprises Ltd.). French Patent 1,382,982. Nov. 16, 1964. Priority date Sept. 25, 1962, Great Britain.

An auto-luminescent light source, consisting of a spherical glass bulb, coated on the exterior with a reflector and on the interior with luminescent material is described. The bulb is filled with tritium and provided with an aperture in which a lens is mounted. To increase the light intensity an additional luminescent body, consisting of one or more transparent support plates coated with luminescent material, is mounted inside the bulb. (auth)

36286 LUMINOUS SOURCES. (to Saunders Roe and Nuclear Enterprises Ltd.). French Patent 1,373,843. Aug. 24, 1964. Priority date Sept. 8, 1962, Great Britain.

A method for uniformly coating the interior surface of a glass bulb with a luminescent material that can be activated by beta radiation is described. The surface is first dusted with powdered phosphor. The bulb is then filled with a solution of H_3PO_4 in ethyl ether and quickly emptied. The ether is almost completely evaporated with hot air and the surface again dusted with powdered phosphor. Finally the bulb is heated to convert H_3PO_4 into $H_4P_2O_7$ which firmly fixes the powder. (auth)

36287 METHOD OF ELECTROCHEMICAL OXIDATION OF ORGANIC COMBUSTIBLES. (to Robert Bosch G.m.b.H.). French Patent 1,392,913. Feb. 8, 1965. Priority date May 15, 1963, Germany.

The current output of a galvanic fuel cell, comprising a hydrocarbon electrode and an oxygen electrode, is increased by incorporation of a radioactive source such as ^{60}Co in the cell. The source may be in or on the hydrocarbon electrode, mixed with the combustible or incorporated in an ion exchange membrane separating anode and cathode. (auth)

36288 RADIOISOTOPE POWERED ATTITUDE CONTROL ENGINE. (to Thompson Ramo Wooldridge Inc.). French Patent 1,395,939. Mar. 8, 1965. Priority date Apr. 8, 1963, United States.

A heated gas intermittent thrustor or rocket engine is described for use as a control engine for attitude stabilization of space satellites, utilizing a radioisotope heat source. British patent 1,003,469 is similar. (auth)

36289 LUMINOUS SOURCE. (to Lenze K.G.). French Patent 1,271,498. Aug. 7, 1961. Priority date Apr. 20, 1959, Germany.

A luminescent light source in which luminescent material is activated by radioactive material, e.g., ^{3}H or ^{85}Kr is described. To increase the light output the luminescent material is applied on supporting means having a thickness $\leq$ the penetration depth of the radiation, e.g., on coaxial, parallel or spiral plates or on a foam support which may consist of lead glass. The source can be provided with a radiation absorbing jacket. (auth)

36290 ELECTRICITY GENERATING GROUP, FED BY ATOMIC ENERGY. (to F. Arbel and Cie). French Patent 1,238,232. July 4, 1960. Filed Feb. 28, 1958.

A thermo-electric nuclear battery is described consisting of a shielded rod of radioactive material that is encircled by a number of annular thermopiles, the hot junctions of which contact the rod while the hot junctions are provided with protruding cooling fins. One or more of these assemblies are mounted in a tube through which a coolant gas passes. (auth)

36291 SYSTEM OF ENERGY CONVERSION. (to Societe Europeenne des Semi-Conducteurs). French Patent 1,364,784. May 19, 1964. Filed May 17, 1963.

A nuclear battery comprises two parabolic mirrors, placed against each other. A spherical radioactive heat source, enveloped by a thin W jacket, is mounted in the center of the enclosure formed by the mirrors while a number of photo-voltaic cells are mounted in the medial plane of said enclosure. The jacket is heated by the source to ca 3000°C thereby emitting luminous radiation which is reflected by the mirrors and converted into electrical energy by the cells. (auth)

36292 ELECTRICAL BATTERY WITH A RADIOACTIVE EMITTER ELECTRODE OF TRITIATED GRAPHITE. Adany, L. French Patent 1,384,042. Nov. 23, 1964. Filed Nov. 20, 1963.

A direct-charging nuclear battery is constituted by an emitter electrode of tritiated graphite, a different collector electrode and an ionizable gas, preferably argon, between the electrodes. (auth)

36293 IMPROVEMENTS IN ELECTROCHEMICAL GENERATORS. (to Yardney International Corp.). French Patent 1,351,389. Dec. 30, 1963. Priority date July 12, 1961, United States.

The spontaneous discharge of an electrochemical battery, due to corrosion of at least one of the electrodes such as occurs in an alkaline Zn–Ag_2O battery, is prevented by means of a nuclear battery connected to the poles of the electrochemical battery. The current delivered by the nuclear battery reverses the corrosion reaction. (auth)

36294 METHOD OF UTILIZING RADIOACTIVE WASTES. (to Yardney International Corp.). French Patent 1,328,285. Apr. 16, 1963. Priority date July 12, 1961, United States.

Methods for generating electric currents in which radioactive waste liquid is made to flow between a shielded and an unshielded electrode are described. A perforated basket-shaped electrode, filled with radioactive waste and a second electrode are suspended in flowing water. The difference in radiation level at both electrodes is said to create an electromotive force. (auth)

36295 IMPROVEMENTS IN ENERGY CONVERTERS. (to Compagnie Francaise Thomson-Houston). French Patent 1,351,191. Dec. 23, 1963. Priority date Mar. 19, 1962, United States.

A nuclear battery comprised of a radioactive heat source, provided with a jacket which emits luminous or infrared radiation, was designed. The source is mounted in the center of a spherical enclosure, the interior wall of which supports a number of photovoltaic cells. (auth)

Materials Testing

Refer also to abstracts 36277, 36849, 38850, and 38852.

36296 (BNWL-SA-901) NONDESTRUCTIVE TESTING: A KEY TO QUALITY ASSURANCE. Worlton, D. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 3, 1966. Contract AT(45-1)-1830. 20p. (CONF-661001-52). Dep. CFSTI.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

Nondestructive testing methods adopted to assure quality of Hanford's high volume fuel production lines and a successful attempt to assure quality of the Hanford N-Reactor heat exchangers are discussed. A method based on the detection and analysis of internal sonic energy, which accompanies the nucleation and propagation of cracks, is described, and typical results of testing 304L stainless steel, A212 carbon steel, and Zircaloy-2 samples to destruction are given. The samples were tested as double cantilever beams. The curves show evidence of onset of crack formation, and show a relatively long period of crack growth before catastrophic growth begins. Temperature shifts (300, 410, and 230°F) in nil ductility temperatures of A302B and A212B steel samples were detected by ultrasonic waves incident upon a surface at the Rayleigh or critical angle. (P.C.H.)

36297 (DP-1082) STANDARDIZED NONDESTRUCTIVE TEST OF CARBON BEDS FOR REACTOR CONFINEMENT APPLICATIONS. Final Progress Report, February–June 1966. Muhlbaier, David R. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). July 1967. Contract AT(07-2)-1. 72p. Dep. CFSTI.

A standardized nondestructive in-place test for detecting leaks in installed carbon beds was developed and demonstrated. Detailed information and a correlating equation for general application of the test to carbon beds of different design are given. (auth)

36298 (GEMP-539) STRESS ANALYSIS OF PERFORATED AND NOTCHED STRIPS BY BOUNDARY COLLOCATION METHOD. Slot, T. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). July 1967. Contract AT(40-1)-2847. 34p. Dep. CFSTI.

A boundary collocation method is described which is used to determine analytically the distribution of elastic stresses and displacements in perforated and notched strips. In materials testing, the method provides a means for the accurate computation of stress or strain concentration factors and gradients in test specimens of finite length. It was found that long strips with regularly spaced holes or notches under longitudinal tension can be treated as short strips with a single perforation or a pair of notches subjected to uniform extension and long strips with regularly spaced holes in lateral tension can be treated as a short strip with a single hole in tension restrained along the sides. (F.S.)

36299 (NP-16858) CAVITATION-EROSION CHARACTERISTICS OF SELECTED MATERIALS IN MERCURY AT 500°F. Technical Report No. 03424-21-T. Kemppainen, D. J.; Hammitt, F. G. (Michigan Univ., Ann Arbor. Lab. for Fluid Flow and Heat Transport Phenomena). Apr. 1967. 25p.

The cavitation resistance of three materials in mercury at 500°F is reported. The materials evaluated were: pure niobium, pure tantalum, and 9M steel (9% chromium, 1% molybdenum, 0.1% carbon). Pure niobium is by far the least resistant to cavitation attack, based on the mean depth of penetration (MDP) in mercury at 500°F. Pure tantalum is far better than niobium and the alloy 9M is the most damage resistant of the materials tested. A comparison of test data from this program is made with data obtained previously under the same conditions. This comparison indicates that alloys of both tantalum and niobium are more resistant to cavitation attack than are the pure materials. The alloy 9M is slightly more resistant to cavitation attack than 304 SS, but slightly less than 316 SS. The mechanical properties of the materials are compared with predicting equations for average MDP rate and show that hardness and tensile strength are the most useful parameters for prediction of relative cavitation resistance of these materials. While the present tests were at 500°F, liquid temperatures in the SNAP boiler are expected to range up to 1100°F. Previous experience indicates that damage may be much less at the elevated temperature due to "thermodynamic effects." (auth)

36300 (SC-DC-67-1972) AUTOROTATION CHARACTERISTICS OF FLAT PLATES AND RIGHT CIRCULAR CYLINDERS AT SUBSONIC SPEEDS. Bustamante, A. C.; Stone, George W. (Sandia Corp., Albuquerque, N. Mex.). July 1967. Contract AT(29-1)-789. 11p. Dep. CFSTI.

Free flight motions of flat plates and right circular cylinders were investigated. The studies were conducted to assess reentry survival of these shapes. The flat plates and cylinders simulate components of radioistopic power generators which should remain intact after landing. In free flight drop tests of rectangular plates from 2000 to 10,000 ft, plates experience autorotation resulting in tumbling motion. The drag coefficient decreased with velocity. Dynamic stability was studied for flat plates and right circular cylinders in a wind tunnel. Steady state autorotation rates which were linear with velocity were exhibited. Dynamic damping coefficients show nonlinear variation with the square of reduced frequency. (F.S.)

36301 (Y-DA-1790) SCOPE OF NONDESTRUCTIVE TESTING. Cofield, R. E. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). July 6, 1967. Contract W-7405-eng-26. 37p. (CONF-670903-10). Dep. CFSTI.

From 22nd Instrument-Automation Conference and Exhibit, Chicago, Ill.

Nondestructive testing is the evaluation of the properties and freedom from defects of materials and structures, without damaging the test material or detracting from its design usefulness. Such quality control methods are very important when high quality and reliability is demanded of a product and when the fabrication cost of an item is a large fraction of its finished value. Nondestructive tests generally determine serviceability properties, such as strength, indirectly by measuring other parameters related to the characteristic of interest. Methods include the use of sensing media such as penetrating radiation (X rays, gamma rays, beta rays, etc.), ultrasonic or high frequency sound waves, micro-

waves, electromagnetic fields, magnetic flux, thermal or infrared energy, and penetrating liquids. Observation of the interaction of these sensing media on the test material or component permit the evaluation of freedom from mass deficiency defects, presence of discontinuities, homogeneity, dimensions and coating thickness, composition, elastic moduli, grain size, radiation characteristics, and other properties. Relative usefulness and limitations of the methods are discussed. (auth)

36302 PROGRESS IN APPLIED MATERIALS RESEARCH. VOLUME 7. Stanford, E. G.; Fearon, J. H.; McGonnagle, W. J. (eds.). Progr. Appl. Mater. Res., 7: 1-355(1967).

Progress is reported in nondestructive methods of relating properties of materials to each other and to the structural factors which produce them. Subjects included are: Ultrasonic Flaw Detection in Very Large Forgings; Semiconductor Materials and Devices; The Future of X-Ray Diffraction in Industry; Structure Aspects of the Creep Properties of Metals and Alloys; Adhesion and Build-up of Films in Arc- and Flame-Spraying; Application of Backscattered Radiation; and the Ultra-sound Camera. A separate abstract was prepared for one paper. (P.C.S.)

36303 TRACK-ETCH PLASTIC-FILM TECHNIQUE FOR NEUTRON IMAGING. Berger, Harold; Kraska, I. R. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 72-3(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36304 HIGH-RESOLUTION NEUTRON RADIOGRAPHY USING PULSED AND STEADY-STATE REACTOR SOURCES. Shoptaugh, J. R. Jr.; Whittemore, W. L. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 73(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36305 CONVENTIONAL NONDESTRUCTIVE TESTING TECHNIQUES FOR FLAW DETECTION. McGonnagle, Warren J. (Associated Midwest Universities, Argonne, Ill.). Trans. Amer. Nucl. Soc., 10: 147(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36306 POTENTIALLY USEFUL NONDESTRUCTIVE TECHNIQUES FOR CHARACTERIZATION OF MATERIAL. McGonnagle, W. J. (Associated Midwest Universities, Argonne, Ill.). Trans. Amer. Nucl. Soc., 10: 148-9(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36307 TESTING OF SPACE VEHICLE FLUID POWER CONTROLS IN NUCLEAR RADIATION. Billet, A. B. (Vickers Inc., Troy, N. Y.). pp 747-58 of Annals of Reliability and Maintainability. Vol. 4. Coutinho, John de S. (ed.). Washington, D. C., Spartan Books Inc., 1965.

From 4th Annual Reliability and Maintainability Conference, Los Angeles, July 28–30, 1965. See CONF-650719.

Results of irradiation testing of hydraulic systems, greases, elastomers, steels, Zircaloy-2, Inconel-X, copper, and servo system components for use in space vehicles are discussed. These results indicate that hydraulic control systems operated in radiation fields satisfactorily, however, elastomers, fluids, and plastics used in these systems were damaged. Recent advances in materials appear to be the basis for production of fluid power control systems that will operate in space under extreme conditions. (J.R.D.)

36308 RING TENSILE TESTER (Engineering Materials). (Univ. of California, Lawrence Radiation Lab., Livermore). (CAPE-1619).

90 drawings.

A tensile test apparatus is described which is used for testing small rings of ductile or brittle materials such as copper, steel, and titanium. The equipment may be hand or automatically operated. Test results show that reasonably accurate tensile data are produced if the strength level is high. Accurate elastic modulus values are obtained from the linear portion of the stress-strain curves. With a small pressure correction, the apparatus produces accurate tensile data. The apparatus is particularly useful in evaluating fabrication processes for materials formed by chemical vapor deposition, electroplating, vapor plating, and plasma plating. (For details see TID-4100 Suppl. 41) (F.S.)

Protective Structures

Refer also to abstracts 36190 and 37539.

36309 (HN-20-1021) THRESHOLDS OF DAMAGE DUE TO GROUND MOTION. Jackson, Melvin W. (Holmes and Narver, Inc., Los Angeles, Calif.). July 1967. 17p. (CONF-670804-4). Dep. CFSTI.

From Symposium on Wave Propagation and Dynamic Properties of Earth Materials, Albuquerque, N. Mex.

Thresholds of damage due to ground motion are summarized. Values based on peak particle acceleration, velocity, displacement, period, and duration have been compared in relation to experience from quarry blasting, nuclear detonations, and earthquakes. Triggering action, as an explanation of damage, and statistical evaluation of damage involving a large number of structures is considered. The use of building codes to establish a damage threshold was considered not valid. Damage thresholds based on structural response spectra may offer potential promise but sufficient data have not been developed for meaningful values. The source of potentially valuable future information from the Los Angeles area is indicated. (auth)

36310 (IITRI-M-6103) DEBRIS FORMATION AND TRANSLATION. Summary. Barnett, Ralph L.; Costello, James F.; Feinstein, David I. (IIT Research Inst., Chicago, Ill.). Nov. 1966. 186p.

The physical basis for predicting the final location of blast-indicated debris was examined. The three principal types of debris were studied. These were frangible structural elements, such as masonry wall panels, nonfrangible structural elements, such as building frames and wood or metal siding and roofing, and building contents. Loads were predicted for frangible and nonfrangible structural elements to predict when they will come apart and the kinds of pieces into which they will break. A computer oriented model was developed for predicting the distribution of loose particles such as structural fragments and building contents. This program SINBAD (Simulated Investigation of Nuclear Blast Associated Debris) is described. (F.S.)

36311 (NP-16938) PREDICTING BLAST-INDUCED BODY MOTIONS OF A BURIED STRUCTURE WITH FOOTINGS. Allgood, J. R.; Carter, W. O. (Naval Civil Engineering Lab., Port Hueneme, Calif.). Aug. 1967. 53p. (R-539). CFSTI.

An approximate theory is presented for predicting the absolute and relative body deflections of shallow-buried shelters in order to provide the designer with a rational approach for selecting footing dimensions. The theory consists of two coupled parts, one that describes the motion of the free field and another that defines the motion of a model of the structure, its foundation, and the covering soil. Soil characteristics are represented by straight-line approximations to the loading and unloading portions of the stress-strain diagram from a one-dimensional compression test. Incremental strains are integrated as the stress wave propagates downward to obtain the absolute free-field displacement at the elevation of the footings. Motion of the structure is represented by a single-degree-of-freedom analog. Empirical functions are used to represent footing reaction and arching in the model of the structure. These functions are incorporated in the differential equation of motion, which is solved with the aid of a digital computer. The results are compared with available test data; velocities and deflections agree reasonably well but the magnitude of the peak accelerations from the theory are larger than the corresponding measurements. Computations performed with the computer code indicate that surface loads above about 100 psi cannot be resisted if the maximum relative deflection between the footing and the floor slab is limited to 2 inches. (auth)

36312 (OAP-TN-21) PARAMETRIC STUDY OF SHELTER COSTS. Goen, Richard L.; Ryan, John W.; Kamradt, Alexander C.; Baum, Sanford; Radovic, Milan (Stanford Research Inst., Menlo Park, Calif.). Dec. 1966. Contract OCD-OS-63-149. 249p.

Summaries of shelter designs and costs of major shelter design studies including methodology, unit costs, major points and shortcomings of each study are discussed and compared. Some of the results are extended to cover a wider range of the parameters and are expressed in terms of shelter volume or floor area. Only direct structural costs are included. Parametric costs of structural elements and of complete shelter structure are derived for reinforced concrete cubicles and arches. An analysis is made of the variation in excavation costs for different locations, soil conditions, and as a function of shelter size based on excavation rates and costs of various kinds of equipment rather than on contract data. Backfill and haul costs are not considered. Shelter entranceway criteria for prompt radiation are reviewed to determine whether the large contribution of entranceway to shelter cost is necessary. Prompt radiation dose distribution is evaluated for a simple minimum entranceway over the range of yield and weapon orientation. Cost data for Corps of Engineers projects were analyzed to provide an indication of contractor costs for overhead, profit, and contin-

gencies, and of government costs for contract administration and support. (F.S.)

36313 (R-OU-230-1) BUDGET ALLOCATION FOR SHELTER SYSTEMS. Final Report. McMullan, P. S.; Wright, J. C.; Anderson, H. S.; Trustman, S. (Research Triangle Inst., Durham, N. C. Operations Research and Economics Div.). June 1967. Contract OCD-PS-64-56. 90p.

A computer model which prepares optimum civil defense shelter postures built upon the base of the current National Fallout Shelter Survey is developed, programmed, and demonstrated. "Optimum" can be based on the user-specified objective of either minimum fatalities or minimum casualties. The user determines the level of risk by supplying an attack environment (both blast and fallout) which is used to calculate the probability of fatality (or casualty) for a person in each existing shelter and in each proposed shelter option in each standard location. Population is then assigned to existing and proposed shelter in an optimum manner, subject to the specified budget. The mathematical formulation is equivalent to a linear program. The model also permits an evaluation of shelter improvement programs against any user supplied attack environment. At the option of the user, the following inputs may be varied: budget level, degree of risk or hazard, definition of shelter fallout or blast vulnerability, and cost per space of shelter. The model has been demonstrated using the state of Rhode Island. Illustrative analyses have been made of the effects of an error in judgment about attack environment, population data base (day or night) at the time of the attack, alternative measures of effectiveness (fatalities or casualties), etc. These cases demonstrate the availability of the model for its intended use in shelter system studies for the Shelter Research Division, Office of Civil Defense. The model will be used primarily in synthesis and analysis of "near future" shelter systems and can be modified for use in more comprehensive system studies (e.g., combined warning, movement, and shelter system studies) and cost-effectiveness evaluations. (auth)

36314 (TO-B-67-25) THE USE OF SCALE MODELS IN STRUCTURE SHIELDING EXPERIMENTS. Final Report, January 3, 1966–December 17, 1966. Kaplan, A. L.; Koepp-Baker, N. B. (Technical Operations, Inc., Burlington, Mass.). Apr. 21, 1967. Contract N0022866C0402. 137p. CFSTI.

Aspects of scale-model shielding data used to predict the shielding effectiveness of full-scale structures were studied. Among the problems considered were the estimate of the far-field contribution and the application of model data to the corresponding full-scale structure. Work results showed that for these two operations, separate treatment of the skyshine and non-skyshine components of the dose rates in the model structure produces good agreement with experimental and theoretical results for full-scale structures. This agreement is significantly better than that obtained by using the total dose rates to perform these operations, as was done in the earlier methods of handling model data. In considering the materials used in model structures, it was found that the use of steel in model experiments on a psf basis to simulate concrete in the full-scale structure produces no difference in barrier reduction, within experimental accuracy, up to a barrier thickness of 150 psf. The results of the evaluation of methods for designing and carrying out scale-model shielding studies and applying the results of these studies to full-scale structures indicate that scale-model experiments can be used to predict the shielding effectiveness of a corresponding full-scale structure to within ±10%. (auth)

36315 MONTE CARLO STUDY OF DIRECTIONAL RESPONSE FUNCTIONS FOR FALLOUT SHIELDING CALCULATIONS. Price, J. H.; French, R. L. (Radiation Research Associates, Inc., Fort Worth, Tex.). Trans. Amer. Nucl. Soc., 10: 404(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36316 CALCULATION OF THE COMPONENTS OF THE EXPOSURE IN A BASEMENT DUE TO FALLOUT. Trubey, D. K. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 404-5(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36317 APPLICATION OF SCALE-MODEL SHIELDING DATA TO FULL-SCALE STRUCTURES. Kaplan, Arthur L. (Technical Operations, Inc., Burlington, Mass.). Trans. Amer. Nucl. Soc., 10: 405-6(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36318 SIMPLIFIED METHOD FOR CALCULATING NITROGEN-CAPTURE AND FISSION-PRODUCT GAMMA-RAY DOSES INSIDE UNDERGROUND CONCRETE STRUCTURES. Marshall, J. D.; Wells, M. B. (Radiation Research Associates, Inc., Fort Worth, Tex.). Trans. Amer. Nucl. Soc., 10: 406-7(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36319 WATER-CONTENT ESTIMATION OF CONCRETE SHIELDS. Hilsdorf, H. (Univ. of Illinois, Urbana). Trans. Amer. Nucl. Soc., 10: 408-9(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36320 A PARAMETRIC STUDY OF X-RAY NUMBER BUILD-UP FACTORS IN SEMI-INFINITE HOMOGENEOUS SINGLE-ELEMENT SLABS. Brooks, Joan; Zerby, C. D. (Union Carbide Corp., White Plains, N. Y.). Trans. Amer. Nucl. Soc., 10: 409-10(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36321 ALGORITHMS FOR HANDLING COMPTON SCATTERING IN MONTE CARLO GAMMA-RAY TRANSPORT CALCULATIONS WITH PHOTON POLARIZATION INCLUDED. Vesely, W. E.; Chilton, A. B. (Univ. of Illinois, Urbana). Trans. Amer. Nucl. Soc., 10: 410-11(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

Radioactive Material Handling

Refer also to abstracts 36141, 36173, 36221, and 36294.

36322 (BNWL-251(Rev.)) EFFLUENT MONITORING AND EVALUATION: A POWER REACTOR DESIGN GUIDE. Roberts, I. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1967. Contract AT(45-1)-1830. 78p. Dep. CFSTI.

A guide to power reactor effluent monitoring is presented which includes discussions of conditions existing during normal operation but does not include an evaluation of accident conditions. Basic requirements of monitoring are presented to aid reactor designers and operators in developing specific systems. Liquid and gaseous effluent, environmental, tank, and pipeline monitoring, sampling, and counting are discussed. Compliance with regulatory requirements, sequential sampling procedures, and a bibliography of 139 references are included. (F.S.)

36323 (BNWL-432) EARTH SCIENCES WASTE DISPOSAL INVESTIGATIONS, JULY–DECEMBER 1966. Eliason, J. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 14, 1967. Contract AT(45-1)-1830. 17p. Dep. CFSTI.

Analytical results are presented for gross β activity in unconfined ground water aquifers and gross β activity in ground water from wells. Results are given where concentrations of radionuclides are above the routine detection limit of 0.08 p Ci/cc. Average concentrations detected during the previous report period are listed. Gross β activity is calculated as ^{106}Ru-^{106}Rh. Analysis was made at specific sites for gross α, ^{3}H, ^{90}Sr, and ^{137}Cs. Gross β and tritium are plotted on water contour maps and iso-concentration lines are drawn to show two-dimensional extent and direction of contamination spread. Ground water quality near disposal sites has changed due to concentration of salts in the waste and indirectly due to the degradation of minerals in the soil by the wastes. Concentrations of nonradioactive materials in the ground water are below the Public Health Service recommended drinking water limits except for nitrate which is above 45 ppM. (F.S.)

36324 (CEA-R-3171) ARMOR: CHAINE $\alpha\beta\gamma$ POUR L'ANALYSE DES COMBUSTIBLES IRRADIES. (ARMOR: An $\alpha\beta\gamma$ Assembly for Irradiated Fuel Analysis). Beraud, Maurice (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Apr. 1967. 43p. (In French). Dep.

The assembly ARMOR, which was built with a view to carrying out research on irradiated fuels, consists of an $\alpha\beta\gamma$ enclosure made up of 11 cells in line. After a general description of the assembly in its present form, the various functions are reviewed: introduction of the samples, chemical decanning, dissolution of irradiated uranium pellets, preparation of solutions for mass spectrometric analyses, and disposal of the effluents and of the solid waste. During the 5 to 6 years of operation of the assembly various improvements were made and a certain number of observations were collected concerning the work. (auth)

36325 (NYO-841-7) THE DISPOSAL OF RADIOACTIVE ^{85}Kr IN POROUS MEDIA. Reist, Parker C. (Harvard School of Public Health, Boston, Mass.). Oct. 29, 1965. Contract AT(30-1)-841. 189p. Dep. CFSTI.

Thesis.

The feasibility of using porous media as storage sites for waste ^{85}Kr gas eliminating the release of this material to the atmosphere

was investigated. The diffusion coefficient for ^{85}Kr in air was measured and diffusion in porous material determined to see how the gas behaves according to diffusion theory and to quantitatively establish the diffusion parameters. The amount of Kr retained in a porous medium when the medium was flushed with air was investigated. The design and application of a Kr underground disposal field for a commercial fuel reprocessing facility was investigated to make an estimate of the cost of this type of disposal. It was concluded that storage and disposal of radioactive Kr in porous media is feasible both technically and economically. It was also found that the estimated cost of such underground storage facilities is much less than conventional surface gas storage, and that leakage of gas from the porous medium is possible by gas diffusion or gas flow caused by a pressure differential. The depth to which the pressures causing these transient flows is noticeable as a function of the properties of the porous bed, and the length of time the pressure differential exists. The addition of moisture to the surface of a porous media containing a waste gas tends to trap that gas within the medium by reducing the ability of the gas to diffuse through the surface to the atmosphere. Injection of Kr into an initially saturated water bearing stratum displaces some of the water in the stratum while the injected Kr bubble expands until pressure equilibrium is reached. Ultimate disposal of the Kr is thus achieved. (J.R.D.)

36326 (ORO-651(Rev.1)) URANIUM HEXAFLUORIDE HANDLING PROCEDURES AND CONTAINER CRITERIA. Keller, E. L. (comp. and ed.) (Oak Ridge Operations Office (AEC), Tenn.). Revised 1967. 84p. Dep. CFSTI.

Handling procedures and container design and utilization criteria of the AEC for UF_6 are summarized. Procedural information concerning the essential aspects of UF_6 weighing, sampling, cylinder emptying, filling, inspection, cleaning, testing, and repair is presented. Shipping procedures are briefly discussed. A brief listing of the chemical and physical properties of UF_6 is included. (F.S.)

36327 765-keV GAMMA RAY ASSAY OF ^{239}Pu IN WASTE DRUMS. Strohm, W. W. (Monsanto Research Corp., Miamisburg, Ohio). Trans. Amer. Nucl. Soc., 10: 41-2(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36328 SOUNDING WITH CAPTIVE AND PILOT BALLOONS IN THE SUPERFICIAL ATMOSPHERIC LAYERS. Giudici, G.; Piloni, M. G. Fis. Sanit. Prot. Radiaz., 10: 247-51(Oct.-Dec. 1966). (In Italian). (RT/PROT-(67)10).

The importance of direct measurements of the characteristics of the atmospheric air over nuclear plants for knowledge of the capacity of diffusion of the atmosphere is considered, and the methods and instruments for investigation of the structure and circulation of the atmospheric air from the ground up to 500 meters to analyze the meteorologic conditions characteristic for each season are described. (tr-auth)

36329 RECENT DEVELOPMENTS REGARDING THE REGULATIONS FOR THE TRANSPORT OF RADIOACTIVE SUBSTANCES. Failla, L. (CNEN, Rome). G. Fis. Sanit. Prot. Radiaz., 10: 111-13(Apr.-June 1966). (In Italian). (RT/PROT (67)2).

During the last two years, IAEA and CIM (International Convention for the transport of goods by rail) have reappraised, in some respects radically, the regulations concerning the transport of radioactive materials. These regulations are mainly security regulations in that they especially regard the prevention of accidents and the limitation of the damage which could follow them, but also involve the field of health protection against radiations, although they do not always supply a complete solution for the health problems involved. The author aims at stressing some of the main features of these regulations as regards protection, and at describing their evolution. (tr-auth)

Vacuum Engineering

36330 (UCRL-13303) METALLIC FRICTION AND ADHESION IN ULTRAHIGH VACUUM. Report MD-67-2. Frisch, J.; Nelson, R. D.; Pfaelzer, P. (California Univ., Berkeley. Coll. of Engineering). Apr. 1967. Contract W-7405-eng-48. 65p. Dep. CFSTI.

Experience in using a strain gage dynamometer in environmental conditions indicates that this method of strain measurement can be successfully employed in ultrahigh vacuum. The particular choice of gage and bonding agent appears to be satisfactory for consistent results under repeated applications of bake-out, low pressure and ion-bombardment. The choice of the dynamometer's geometric configuration fitted the particular experiments for two-force measurements during friction-adhesion tests of metallic surfaces. (auth)

36331 IONIZATION GAGES WITH REDUCED ELECTRONIC DESORPTION EFFECTS. Groszkowski, J. (Inst. of Electronic Tech., Warsaw. Technical Univ., Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Tech., 15: 347-56(1967).

The design of a modified Bayard-Alpert-Redhead ionization gage, designated the Anti-Desorption Modulation Gage (ADMG), is described. In the gage, the electron current density was increased while the collector efficiency for surface ions was lowered. Electron current density increase is achieved by concentration of the electron current on the anode half surface and collector efficiency for surface ions was lowered by facilitating the escape from the anode space of ions originating on the anode surface. (F.S.)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 35868, 35872, 36070, 36150, 36163, 36575, 36585, 37200, 37208, 37210, 37214, 37955, 38251, and 38527.

36332 (AECL–2700) MONITORING FOR TRITIUM AT LOW LEVELS. Osborne, R. V. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). July 1967. 9p. (CONF-670704–6). Dep. CFSTI. CAN $0.50.

From IAEA Symposium on Instruments and Techniques for the Assessment of Airborne Radioactivity in Nuclear Operations, Vienna, Austria.

Tritium presents little external radiation hazard because the beta rays it emits have very low energy. However, the tritium produced by neutron capture in heavy water reactors is in the form of tritiated water which, if it escapes into the air, may be absorbed into the body through the lungs and skin. Direct measurement of tritiated water vapor (HTO) in air at levels below one $(MPC)_a$ is difficult with existing installed or portable monitors. However, an indirect measurement can be obtained by making frequent routine determinations of the amount of tritium absorbed by the workers who are chronically exposed. In addition, individual doses may be estimated directly. For this approach to area monitoring to be useful to a health physicist, rapid, direct measurement of HTO intake is needed. Analyses for tritium carried out in the laboratory usually involve delays so an automatic urinalyser has been developed. It will detect body burdens of tritium resulting from chronic exposures to 0.05 $(MPC)_a$. Urine is voided into a urinal attached to the analyser; a sample is automatically metered and mixed with liquid scintillator and the tritium activity is then measured. The assay takes less than two minutes. Performance of the instrument is automatically checked by processing standard and background samples. This method may also be used for monitoring planned acute exposures. The sensitivity is 5 $(MPC)_a$.h. although accurate measurements can only be made when the HTO has dispersed throughout the body, one to two hours after the exposure. Tritium hazards at specific places may be monitored by collecting airborne HTO in water bubblers and then measuring the collected tritium with the urinalyser. Concentrations of HTO in air down to 0.01 $(MPC)_a$ may be detected. Since no manual processing of urine or other aqueous samples is needed the instrument is well suited to those nuclear installations such as power stations where minimal laboratory backup facilities are available. (auth)

36333 (BNWL–506) ON-LINE COMPUTER STORAGE AND RETRIEVAL OF PROCESSED GAMMA SPECTRA DATA. Coffin, L. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1967. Contract AT(45-1)-1830. 86p. Dep. CFSTI.

Included are: descriptions of digital computer programs which allow the on-line storage of processed gamma spectra data and the retrieval of this data for on-line reports and program corrections, extensions, and clarifications pertaining to the on-line analysis of the gamma spectra described. (auth)

36334 (CERN–67-13) TEST RESULTS OF DIGITIZED WIDE-GAP WIRE CHAMBERS. Chikovani, G. E.; Fischer, M.; Focacci, M. N.; Kienzle, W.; Laverriere, G.; Lechanoine, C.; Levrat, B.; Martin, M.; Schuebelin, P. (European Organization for Nuclear Research, Geneva (Switzerland)). May 9, 1967. 47p. Dep.

The design and operation of a digitized wide-gap wire spark chamber with magnetostrictive readout is described. The efficiency of the system was tested with π^--p scattering. (B.G.D.)

36335 (CERN/DI/HP–90) PARTICLE FLUX MEASUREMENTS WITH ACTIVATION DETECTORS. Charalambus, St.; Dutrannois, J.; Goebel, K. (European Organization for Nuclear Research, Geneva (Switzerland)). July 14, 1966. 76p. Dep.

Nuclear reactions yielding radionuclides which can be conveniently used for flux density measurements are described. An account is given of the use of such reactions at CERN, and generally, near high-energy accelerators. Such reactions are usually selected from practical considerations, the main requirements of which are a sufficiently high cross section, a convenient half-life, and the possibility of a straight-forward measurement. (S.F.L.)

36336 (DESY–67/14) MEASUREMENTS ON THE FORMATION, GROWTH, AND RECOMPRESSION OF BUBBLES IN LIQUID HYDROGEN. Harigel, G.; Horlitz, G.; Wolff, S. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). May 1967. 39p. Dep.

In the 85 cm bubble chamber photographs of electron tracks with a momentum of about 2 GeV/c were taken with a scale-one optical system in bright-field illumination. Growth and recompression of bubbles as well as bubble density were observed between 24.5 and 28.0°K. Bubble radius as a function of time was measured at different temperatures, with minimum and static pressures as variable parameters. A comparison between different theories on the behavior of bubble growth and recompression is given. (auth)

36337 (INR–800/II/PS) ON THE PREPARATION OF LITHIUM-DRIFTED SILICON DETECTORS. Przyborski, Wincenty; Chwaszczewska, Janina; Czarnacki, Wieslaw (Inst. of Nuclear Research, Warsaw (Poland)). 1967. 25p. Dep.

The results of a study of lithium mobility in boron and gallium doped silicon single crystals grown either by zone floating or Czochralski's methods are given. The influence of dislocations on the drift process, compensation quality and reverse current of Li-drifted diodes is outlined. A description of Li-drifted detector preparation technique, involving some novelties, is presented. (auth)

36338 (INT–48) THE CALIBRATION OF RADIATION DETECTORS USED IN SEDIMENT TRACER INVESTIGATIONS BY THE HYDRAULICS RESEARCH STATION. Crickmore, M. J.; Waters, C. B. (Ministry of Technology, Wallingford (England). Hydraulics Research Station). Jan. 1966. 31p. Dep.

The methods by which three types of radiation detectors, a portable Geiger–Mueller counter, a fixed Geiger–Mueller counter, and a scintillation detector are calibrated for use in sediment tracer investigations by the Hydraulics Research Station are discussed. (B.G.D.)

36339 (KAPL-M–6591) NEUTRON CRYSTAL SPECTROMETER FOR MATERIAL ANALYSES. Gavin, D. A. (Knolls Atomic Power Lab., Schenectady, N. Y.). Mar. 21, 1967. Contract W-31-109-eng-52. 29p. Dep. CFSTI.

A neutron crystal spectrometer was developed at KAPL for the analysis of materials common to reactors. The pertinent features of the spectrometer and the characteristics selected in the optimization of its design are described. Typical applications to reactor materials are discussed. (auth)

36340 (ORNL–4114) SYSTEM RESPONSE FUNCTIONS FOR FLIGHT-TIME SPECTROMETRY OF SECONDARY FAST NEUTRONS. Santoro, Robert T. (Oak Ridge National Lab., Tenn.). Aug. 1967. Contract W-7405-eng-26. 105p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee [Knoxville].

Time-channel response functions were derived for a time-of-flight spectrometer used to measure monoenergetic secondary neutrons in the energy region from 2 to 100 MeV, produced in homogeneous slab targets from the interactions of monoenergetic charged particles with the target nuclei. The effects on the flight-time distribution of the target and detector dimensions and orientation, the spatial distribution of the beam, and the pulse-height-dependent time slewing (walk) were demonstrated. Response functions were derived assuming that the neutron emission from the target is independent of the azimuthal scattering angle and the polar angle over the angular region subtended by the detector, that neutron detection may be treated in the first collision approximation with the light being emitted uniformly from the interaction point and collected uniformly from all points in the detector volume, that the beam dimension perpendicular to the scattering plane can be ignored, and that the instrumental timing jitter can be approximated by a Gaussian distribution independent of the pulse height. The time-channel response functions were obtained from the integral over the time-analyzer response function of the convolution of the physical flight-time distribution of detected neutrons and the time-slewing response function. The maximum flight-time uncertainties, $\Delta t/t$, were derived in terms of the target and detector dimensions assuming that all dimensions have negligible effect except the one being evaluated. Comparisons are made between the computed distributions and those obtained analytically. The expected dominant effects of the detector thickness are demonstrated along with the dependence of the target dimensions on the neutron velocity and the angular difference between the neutron scattering angle and the target rotation angle. The distributions arising from the target and detector thickness were shown to be square except for attenuation effects, while those obtained for large detector radii showed a $1/t$ dependence. The time distribution for large beam size reflects the beam spatial distribution. The numerical methods are described, and typical distributions illustrate each contribution to the overall response function. Where multiple scattering does not dominate, the time integral of the computed response functions are in good agreement with known detector efficiencies. (auth)

36341 (ORNL-TM–1638(Pt.2)) NUCLEAR INSTRUMENT MODULE MAINTENANCE MANUAL. PART 2. CHAMBER

HIGH VOLTAGE SUPPLY AND FLUX AMPLIFIER, ORNL MODEL Q-2602. Nutt, R.; Anderson, J. L. (Oak Ridge National Lab., Tenn.). May 31, 1967. Contract W-7405-eng-26. 25p. Dep. CFSTI.

The flux amplifier is a low-level dc amplifier that amplifies current in the range of 10^{-10} to 10^{-4} amp from an ionization chamber. Its principal application is the measurement of neutron flux for the safety system of a nuclear reactor. An ion chamber high-voltage supply, a dc-to-dc converter, is contained in the same module to supply the associated ion chamber with +250 v dc. The instrument is a standard plug-in module of the ORNL Modular Reactor Instrumentation Series. (auth)

36342 (ORNL-TM-1870) DESCRIPTION OF FACILITY CONTAMINATION ALARM SYSTEM INSTALLED IN THE PHYSICAL EXAMINATION HOT CELLS, BUILDING 3025. Russell, J. A. Jr.; Knowles, D. J. (Oak Ridge National Lab., Tenn.). May 18, 1967. Contract W-7405-eng-26. 19p. Dep. CFSTI.

A Facility Contamination Alarm System was installed in the hot cell section of Building 3025 to continuously and automatically monitor air contamination (by three beta-gamma air monitors) in the entire facility. These instruments and other components in the network provide health physics monitoring information, sound local alarms when abnormal conditions occur, and indicate these conditions on a central panel board in the operating area. Operating personnel are first given warning when air-borne contamination is detected by a constant air monitor or a mobile air monitor reaches a preset caution level. A second warning is given when the high-level set point is reached. The building evacuation system operates automatically when two or more air monitors detect a high level of air contamination. (auth)

36343 (ORO-3224-11) APPLICATIONS OF A PORTABLE RADIOISOTOPE X-RAY FLUORESCENCE SPECTROMETER TO ANALYSIS OF MINERALS AND ALLOYS. Rhodes, J. R.; Furuta; T. (Texas Nuclear Corp., Austin). July 14, 1967. Contract AT(40-1)-3224. 61p. (CONF-670813-1). Dep. CFSTI.

From 16th Annual Conference on Applications of X-Ray Analysis, Denver, Colo.

A portable, battery-operated x-ray fluorescence analyzer weighing 15 lbs is described consisting of a NaI(Tl) scintillation counter probe and an electronic unit with a single channel pulse height analyzer and reversible scaler. Radioisotope x-ray sources are used for excitation of the sample and, where necessary, balanced filters for resolution of neighboring characteristic x-rays. Emphasis was placed on designing and producing an instrument that is easy and convenient to operate in laboratory, factory or field conditions, and that can equally well be used to measure extended surfaces, such as rock faces, or finite samples in the form of powders, briquettes or liquids. The feasibility of the following analyses was studied, using for each determination the appropriate radioisotope source and filters: sulfur in coal; calcium and iron in cement raw mix; copper in copper ores; and vanadium, chromium, molybdenum and tungsten in steels. Detection limits, based on counting statistics obtained in count times of 10 to 100 seconds, range from 0.03% for copper in ores to 0.2% for sulfur in coal. Both matrix absorption and enhancement effects were encountered and were eliminated or reduced substantially by suitable choice of source energy, by the use of nomograms or by semi-empirical correction factors based on attenuation or scattering coefficients. (auth)

36344 (PEL-148) VLOED: A FORTRAN IV DATA REDUCTION AND FLUX CALCULATION PROGRAM WRITTEN FOR USE ON THE IBM-360 DIGITAL COMPUTER. Visser, J. D.; van der Walt, R. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). May 1967. 15p. Dep.

The program described was developed with the purpose of deriving neutron flux and spectrum parameters from foil data obtained after irradiation in the SAFARI I reactor and the Pelindaba critical facility. It is written for use on a 128K model 40G IBM-360 digital computer. The program requires 41423 bytes on the DOS-11 release 7 of IBM system 360, with a supervisor occupying 8191 bytes—thus using approximately 32% of the core space. (auth)

36345 (RFP-980) LOW-ENERGY X-RAY MEASUREMENTS OF SOME TRANSURANIC ELEMENTS WITH A LITHIUM-DRIFTED SILICON DETECTOR SYSTEM. Tyree, William H. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Aug. 8, 1967. Contract AT(29-1)-1106. 4p. Dep. CFSTI.

A lithium-drifted silicon [Si(Li)] detector system was used to measure the L x-ray photon energies of plutonium 238, plutonium 239, americium 241, and curium 244 with a measurement error of ±50 electron volts. (auth)

36346 (SC-DC-67-1572) NEUTRON SPECTROSCOPY BY FOIL ACTIVATION IN RADIATION EFFECTS STUDIES. Halbleib, J. A.; Walker, J. V.; Greer, C. L. (Sandia Corp., Albuquerque, N. Mex.). July 1967. Contract AT(29-1)-789. 28p. (CONF-670708-2). Dep. CFSTI.

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio.

A technique for obtaining spectral information from foil-activation data is described. The technique is based upon the determination of an iterative algorithm that arises from the minimization of a least squares error. (D.C.W.)

36347 (SLAC-PUB-329) DESIGN, CONSTRUCTION, AND PERFORMANCE OF A 5800 KW (11,000 amp) POWER SUPPLY FOR A SPARK CHAMBER MAGNET. Harris, C. A.; Edwards, Paul (Stanford Linear Accelerator Center, Calif.). July 1967. Contract AT(04-3)-515. 10p. (CONF-670705-9). Dep. CFSTI.

From 2nd International Conference on Magnet Technology, Oxford, England.

A 5,800-kW (525 V at 11,040 A) power supply for energizing a bubble chamber magnet having an 80-inch diameter pole is discussed. Topics include physical construction, control system, ac power system, dc power system, regulation system, radio-frequency interference, and provisions for testing and monitoring. (B.G.D.)

36348 (UCRL-17555) RECENT ADVANCES IN PARTICLE IDENTIFIERS AT BERKELEY. Goulding, F. S.; Landis, D. A. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1967. Contract W-7405-eng-48. 17p. (CONF-670520-4). Dep. CFSTI.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn.

Recent advances made at Berkeley in techniques of particle identification using semiconductor detectors are summarized. The performance of the identifiers is discussed. Attention is restricted to particles (p, d, t, α, and light ions) in the energy range 5 to 100 MeV (depending upon the type of particle). The identification method used has proved to be very versatile and may be applied with appropriate restrictions to other ranges. (C.E.S.)

36349 (UCRL-17556) THE ENERGY RESOLUTION CAPABILITIES OF SEMICONDUCTOR DETECTORS FOR PARTICLES IN THE 10 TO 100 MeV RANGE. Goulding, F. S.; Landis, D. A.; Pehl, R. H. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1967. Contract W-7405-eng-48. 16p. (CONF-670520-5). Dep. CFSTI.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn.

Notes which were prepared in order to make a serious estimate of the performance one can ultimately expect to realize with semiconductor detectors for energy resolution for particles in the 10 to 100 MeV range are presented. Conditions necessary for this performance are indicated. Discussions of present performance are also included. The discussion is restricted to lithium-drifted silicon detectors 1 to 4 mm thick. (C.E.S.)

36350 (UCRL-17557) HIGH VOLTAGE OPERATION OF LITHIUM-DRIFTED SILICON DETECTORS USING A SHELF STRUCTURE. Goulding, F. S.; Lothrop, R. P. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1967. Contract W-7405-eng-48. 6p. (CONF-670520-6). Dep. CFSTI.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn.

A shelf structure which is used to increase the breakdown voltage of lithium-drifted silicon detectors and to make surface treatment less critical is illustrated. The basic process for constructing such a structure is outlined. (C.E.S.)

36351 (UCRL-17558) SOME OBSERVATIONS OF RADIATION DAMAGE IN LITHIUM-DRIFTED SILICON DETECTORS IN NUCLEAR REACTION EXPERIMENTS. Goulding, F. S.; Lothrop, R. P. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1967. Contract W-7405-eng-48. 4p. (CONF-670520-7). Dep. CFSTI.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn.

Examples of radiation damage observed during several years of using large quantities of lithium-drifted silicon detectors are summarized. The observations supplement and to some extent differ from those reported previously. (C.E.S.)

36352 (UCRL-17559) INTRODUCTION TO LOW-NOISE PREAMPLIFIERS FOR NUCLEAR SPECTROMETRY. Goulding, F. S. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1967. Contract W-7405-eng-48. 14p. (CONF-670520-8). Dep. CFSTI.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn.

The performance of semiconductor detectors and their associ-

ated FET preamplifiers in nuclear spectrometry is discussed, and noise mechanisms in FET's are considered. (C.E.S.)

36353 (UCRL–17560) DESIGN AND PERFORMANCE OF A HIGH-RESOLUTION HIGH-RATE AMPLIFIER SYSTEM FOR NUCLEAR SPECTROMETRY. Goulding, F. S.; Landis, D. A.; Pehl, R. H. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1967. Contract W-7405-eng-48. 27p. (CONF-670520–9). Dep. CFSTI.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn.

A brief outline of a high-resolution high-rate amplifier system for gamma spectroscopy is presented, and some of the results achieved are discussed. The system described allows counting rates more than 10 times as high as previously with virtually no sacrifice of energy resolution. (J.F.P.)

36354 (UCRL–17589) DAPR: DIGITAL AUTOMATIC PATTERN RECOGNITION FOR BUBBLE CHAMBERS. White, Howard S. (California Univ., Berkeley. Lawrence Radiation Lab.). May 29, 1967. Contract W-7405-eng-48. 29p. (CONF-670541–1). Dep. CFSTI.

From Symposium on Automatic Photointerpretation, Washington, D. C.

The Digital Automatic Pattern Recognition DAPR system for automatic scanning of bubble chamber pictures is described. Experience with DAPR is also summarized. (B.G.D.)

36355 (SC–T–67–0944) DEVICE FOR MEASURING HARD X-RAY GAMMA RADIATION. Gross, Bernhard. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from German Patent 1,107,350. 12p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

A device for the measurement of hard x ray and gamma radiation, during which the current generated by the so-called Compton secondary electrons, and carried by it, is measured directly in a nonconductor which serves as a scattering body, is described. (B.G.D.)

36356 WHOLE-BODY MEASUREMENTS WITH NaI CRYSTALS. SENSITIVITY AND ACCURACY OF MEASUREMENTS WITH VARIOUS DETECTOR ARRANGEMENTS. Schneider, Claus; Linden, Walfried A. (Univ., Hamburg). Strahlentherapie, 133: 213-32(June 1967). (In German).

Using a whole-body counter with four NaI crystal detectors, the sensitivity and accuracy of the four used for whole body counting were compared: single crystal device with tilting chair, line arrangement of the detectors, simple scan measurements with two and four detectors. The highest sensitivity for the detection of γ-sources was obtained with the tilting chair device; it was reduced for about 20% in the line arrangement and for about 50% in the scan measurements. Sources distributed irregularly in the body were measured, with greater accuracy, with four detectors in line (using the optimum conditions as obtained with a computer program) than by the use of the tilting chair device and the simple scan measurements. In the case of radioprotective investigations, preference should be given to the linear device; scan measurements are not suitable at all. In the case of clinical problems the line device as well as the modified scan measurements, as described in this paper, are recommended; the tilting chair device is not suitable. (auth)

36357 APPLICATION OF A SIMPLE WHOLE-BODY COUNTER TO RADIATION PROTECTION. Rab Molla, M. A.; Simpson, J. D. (Royal Infirmary, Edinburgh). Health Phys., 13: 861-7(Aug. 1967).

A simple whole-body counter, designed for clinical applications, with a modest amount of shielding close to the NaI crystal, is shown to have adequate sensitivity for use in connection with radiation protection. (auth) (UK)

36358 EFFECTIVE CADMIUM CUTOFF ENERGIES FOR FINITE CYLINDRICAL FILTERS WITH FINITE-SIZE DETECTORS. Glickstein, S. S.; Hall, W. J. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 10: 183-4 (June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36359 AIRBORNE PLUTONIUM MONITOR WITH ALPHA SPECTROMETER. Minami, K.; Watanabe, K.; Fukuda, S.; Naritomi, M. (Japan Atomic Energy Research Inst., Tokyo). Radioisotopes (Tokyo), 16: 383-90(Aug. 1967). (In Japanese).

An alpha air monitor was developed to detect the very low levels of airborne plutonium and for routine air monitoring at the plutonium handling laboratory of JAERI. The results of performance tests of this device is described and the detectability for airborne plutonium is discussed. The 5.1-MeV alpha particle of plutonium, collected on a fixed filter paper through which air was drawn at a flow rate of 250 l/min, was distinguished from the naturally occurring alpha emitters by spectrometry, using 5 cm $\phi \times 1$ mm CsI(Tl) crystal. The count rate in the plutonium channel due to alpha particles of degraded energy was compensated by the count rate in the upper channel due to alpha particles having an energy higher than 5.5 MeV by using a differential amplifier. Good correlation between the count rates in both the channels was obtained in the absence of the airborne plutonium, so that the background count rate in the plutonium channel was compensated satisfactorily by adjusting properly the output voltage of rate meter for the upper channel. The minimum detectable amount is 2 $(MPC)_a \cdot hr$ with the background level of 10^{-11} $\mu Ci/cm^3$ of Rn daughters. (auth)

36360 A METHOD OF MEASUREMENT OF AFTER-PULSES OF G–M COUNTER USING THE RI CHOPPER. Narita, Yuichi (Univ. of Akita, Japan). Radioisotopes (Tokyo), 16: 357-62(Aug. 1967). (In Japanese).

A method for measurement of after-pulses of G–M counter using the RI chopper is described. The G–M counter was alternatively irradiated with β-rays by the RI chopper. Output pulses of G–M counter, whose pulses must be counted during the time of no radiation of β-rays, were supplied to synchronize with RI chopper for coincident gate circuit. Therefore, only the after-pulses were counted. The result of after-pulses measurement using the arrangement was not different from experimental results, with the pulse modulated irradiation. The rate of generation of after-pulse increased together with the intensity of radiation and an anode voltage of the G–M counter. It is possible, therefore, to measure the characteristics of the after-pulse even if such a simple device as the RI chopper is used. (auth)

36361 LUNAR-SURFACE NUCLEAR EXPERIMENT PACKAGE. Ebeoglu, D. B. (Bendix Aerospace Systems Div., Ann Arbor, Mich.). Trans. Amer. Nucl. Soc., 10: 21-2(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36362 RISE-TIME SHAPER FOR PROPORTIONAL COUNTER PULSE-HEIGHT SPECTROMETERS. McLain, R. E.; Beller, L. S. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 10: 312-13(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36363 REGENERATIVE IN-CORE THERMAL-NEUTRON DETECTOR. Jackson, Charles N. Jr. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 310-11 (June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36364 RECENT ADVANCES IN RADIOISOTOPE ASSAY CALORIMETERS. Box, W. D.; Posey, J. C. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 51-2(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36365 DETAILED ANALYSIS OF A PLUTONIUM-FUELED CAPSULE BY GAMMA SCANNING. Holm, Dale M.; Sanders, Wm. Mort (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 10: 68(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36366 DESIGN AND PERFORMANCE OF A ^{235}U LEVEL MONITOR FOR INSPECTION OF REACTOR FUEL CORES BY GAMMA ANALYSIS. Twitty, B. L. (National Lead Co. of Ohio, Cincinnati). Trans. Amer. Nucl. Soc., 10: 42-3(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36367 THE ANALYSIS OF GROSS FISSION PRODUCTS USING Ge(Li) SPECTROMETERS. Murri, E. L. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc., 10: 68-9(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36368 APPLICATION OF SOLID-STATE DETECTORS TO ENVIRONMENTAL AND BIOLOGICAL PROBLEMS. Cooper, J. A.; Wogman, N. A.; Palmer, H. E.; Perkins, R. W. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 78-80(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36369 COMPUTER EVALUATION OF DIGITIZED MICROSCOPE DATA. Suranyi, Gyorgy; Telbisz, Ferenc. KFKI (Kozp. Fiz. Kut. Int.) Kozlem., 15: 239-49(1967). (In Hungarian).

36370 A METHOD FOR MEASUREMENT OF γ–γ COINCIDENCES AND ANGLE CORRELATIONS OF γ-RADIATION IN THE

(n,γ) REACTION. Bogdanov, A. P.; Firsov, E. I. Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk, No. 2, 115-20(1966). (In Belorussian).

A method for measuring γ-γ coincidence and the angular correlation of gamma radiation in (n,γ) reactions. Two lead-shielded NaI(Tl) scintillation counters in a fast-slow coincidence circuit are the gamma detectors. (B.G.D.)

36371 HIGH RESOLUTION ZERO-CROSSING DETECTOR FOR LONG CROSSOVER TIMES. Bucher, W. P.; Hollandsworth, C. E. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Rev. Sci. Instrum., 38: 1259-63(Sept. 1967).

A circuit designed to detect the zero-crossing of bipolar pulses having crossover times of 100 nsec or greater is described. True zero-crossing detection is accomplished by using an external strobe to generate a pedestal which is then applied to a tunnel diode, normally biased off, allowing it to switch when the input signal crosses zero. Tests with scintillation pulses show that amplitude-dependent timing errors are less than 0.25 nsec for a pulse-height range of 100. The principal application of the circuit is in the separation of scintillation pulses according to their pulse shapes. (auth)

36372 APPLICATION OF FERMAT'S PRINCIPLE TO MAGNETIC SPECTROMETERS. Bounin, Paul (Ecole Normale Superieure, Orsay, France). Rev. Sci. Instrum., 38: 1305-12(Sept. 1967).

The principle of Fermat (or of Maupertuis) contains implicitly the entirety of geometrical optics. It is used to find the trajectories of charged particles passing through magnetic systems possessing a plane of radial symmetry. A general formula is given for the calculation of the aberrations at image points. The method is illustrated in its application to certain systems of special interest in which specific second order aberrations cancel. The method outlined herein is believed to possess the advantage of relative simplicity and directness when compared to more general formulations. (auth)

36373 DESIGN CRITERIA FOR A HIGH-PERFORMANCE LIQUID SCINTILLATION SYSTEM. Frank, Richard B.; Andersen, Jacques C. (Nuclear-Chicago Corp.). Nucleus (Chicago), No. 21, 1-6(Jan. 1967).

The application of liquid scintillation counting to radio tracer studies is complicated by the wide variations in counting efficiencies typically encountered. Of the several techniques for determining counting efficiency presently in use, the channels ratio is most conveniently adapted to automatic or semi-automatic operation. Statistical limitations of the method, when applied to low activity samples, can be largely overcome by the use of an external gamma ray source to generate an energy distribution in the region of interest, upon which the channels ratio can be applied. The considerations involved in the choice of an isotope for the external source, and the design of a special purpose integrated circuit digital computer, which automatically performs all calculations leading to the determination of counting efficiency, are described. (auth)

36374 RESONANCE DETECTORS FOR MOESSBAUER EXPERIMENTS. Muray, J. J. (Physics International Co., San Leandro, Calif.); Worster, Bruce W. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 4, 11-16(Aug. 1967).

The Moessbauer effect can be observed by detecting the gamma rays or the internal-conversion electrons and x rays that are emitted in the de-excitation of nuclei excited previously by the resonance absorption of gamma rays. The use of conversion electrons for recording the resonance absorption is limited by the short range of these electrons. However, in special detectors—gas proportional and thin plastic scintillators—where the absorber is an integral part of the device, the detection can be made quite efficiently. The properties (counting efficiency, background, and line shape) of these resonance detectors will be discussed and compared with experimental data. It will be shown that in certain geometrical configurations the line width can be reduced whereas its shape remains very close to the Lorentzian. The detector used in this experiment is a flat gas-flow proportional detector in which the cathode surface is coated with iron enriched in the isotope ^{57}Fe. The relative merits of the different detection systems will be discussed briefly. (auth)

36375 LOW-NOISE CHARGE-SENSITIVE PREAMPLIFIER FOR A GERMANIUM DETECTOR. Deschamps, J.; Le Scornet, J. C.; Marcus, L. (Faculte des Sciences, Orsay, France). Rev. Phys. Appl., Suppl. J. Phys., 2: 114-20(June 1967). (In French).

Results on a very low noise charge sensitive preamplifier using a cooled field effect transistor for a lithium-drift germanium gamma detector are described. (auth)

36376 USE OF A MOIRE FRINGE MEASURING SYSTEM AND DIGITAL OUTPUT IN A SOFT X-RAY SPECTROMETER. Watson, L. M.; Dimond, R. K.; Fabian, D. J. (Univ. of Strathclyde, Glasgow). J. Sci. Instrum., 44: 506-8(July 1967).

A description is given of the installation of a moiré fringe angular measuring system in a soft x-ray spectrometer for accurate detection of fine structure in valence electron bands of metals and alloys. Automatic iterative scanning gives digital output and facilitates the summing of repeated spectra to decrease statistical error. (auth) (UK)

36377 USE OF DEUTERATED ORGANIC SCINTILLATORS IN NEUTRON SPECTROMETRY. PART I. THE PROPERTIES OF ORGANIC SCINTILLATORS CONTAINING DEUTERIUM. Belikova, G. S.; Belyaev, L. M.; Benetskii, B. A. (Inst. of Crystallography, Moscow). Isotopenpraxis, 3: 133-5(Apr. 1967). (In Russian).

Single crystals of deuterated naphthalene were produced and activated by anthranilic acid for their use in fast neutron spectrometry. Utilizing these crystals is advantageous, since in elastic collisions of neutrons with deuterium a spectrum of secondary particles is obtained, in which the distribution maximum of the secondary particles corresponds to the neutron energy E. (auth)

36378 Ge(Li) DETECTORS WITH UNUSUAL OPERATING CHARACTERISTICS. Sher, A. H.; Pate, B. D. (Simon Fraser Univ., Burnaby, B. C.). Nucl. Instrum. Methods, 53: 339-40 (1967).

Ge(Li) detectors of up to 1.5 cm^3 active volume were operated at average biases of 70 V with good charge collection and resolution. The possible effect of detector shape on performance is discussed. (auth)

36379 CaF_2 COMPENSATION OF SURFACE STATES IN Ge(Li) DETECTORS. Sher, A. H.; Pate, B. D.; O'Hanlon, J. F.; Haering, R. R. (Simon Fraser Univ., Burnaby, B. C.). Nucl. Instrum. Methods, 53: 341-5(1967).

A CaF_2 vacuum deposition technique is described for setting surface states in Ge(Li) detectors. Evidence is discussed for the protection of the junction edges from the effects of exposure to atmospheric ambients. (auth)

36380 TIMING CIRCUIT FOR Ge(Li) DETECTORS. Gorni, S.; Hochner, G.; Nadav, E.; Zmora, H. (Hebrew Univ., Jerusalem). Nucl. Instrum. Methods, 53: 349-51(1967).

A limiter for timing with Ge(Li) detectors is described. The limiter gives an additional output proportional to the rise times of the pulse, which is used to compensate for the walk caused by the spread in pulse rise time. The time resolution achieved at 511 keV was 2.7 ns (fwhm) for a 3 mm detector and 4 ns for an 8 mm detector. (auth)

36381 TABULATED EFFICIENCIES OF SOME WELL-TYPE GAMMA RAY SCINTILLATION DETECTORS FOR VARIOUS GEOMETRIES. Snyder, B. J. (Atomic Energy Commission, Washington, D. C.). Nucl. Instrum. Methods, 53: 313-19(1967).

Calculated absolute total efficiencies of well-type scintillation crystals are tabulated for monoenergetic gamma rays between 10 keV and 6 MeV. Results are given for source geometries of points (on and off the crystal axis of symmetry), circular disks, and cylindrical volumes centered on the crystal axis. Results for cylindrical volume sources are given for solid crystals, in addition to well-type crystals. An isotropic point kernel equation is given and extended to the various source geometries. Calculations were performed by Gaussian quadrature numerical integration on the IBM-7090 and computer programs are available. More extensive tabulations of data are available, upon request from the author. (auth)

36382 ON THE SOLUTION OF RADIOACTIVE SOURCES IN NaI(Tl) CRYSTALS. Schulz, G. (Univ., Heidelberg). Nucl. Instrum. Methods, 53: 320-4(1967).

Several elements form mixed-crystals with NaI(Tl). Radioactive isotopes of these elements can be dissolved in NaI(Tl) crystals and used for various problems of nuclear spectroscopy. A chemical and a physical criterion for mixed-crystal formation is presented. Applying these criteria, it is shown that Rb, Cs, Ba, Os, Tl, Pb form mixed-crystals with NaI(Tl), whereas P, Ca, Mn, Zn, As, Y, Sn, Ce, Bi do not. (auth)

36383 DISCRIMINATION BY HALFWIDTH AND PULSE LENGTH IN THE ^{6}LiF–ZnS SCINTILLATION DETECTOR FOR SLOW NEUTRONS. Albold, E.; Huber, U. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods, 53: 325-9 (1967).

^{6}LiF – ZnS scintillation detectors for slow neutrons have the disadvantage of relatively high γ-sensitivity and multiplier noise

contributions in the case of low counting rates. A new pulse shape discrimination circuit is described which overcomes these difficulties. The principle of the procedure, the details of the circuit and results of performance measurements are reported. (auth)

36384 LOW-NOISE NANOSECOND-PULSE AMPLIFIER. Nybakken, T. W. (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). Nucl. Instrum. Methods, 53: 331-4 (1967).

A new four-stage voltage-mode amplifier with a rise time <1 nsec at a voltage gain of 170 was developed for use with fast, small signal, radiation detectors. The amplifier exhibits improved performance at low operating temperatures (~77°K). (auth)

36385 ACTIVATION DETECTORS FOR 2.50-MeV PULSED NEUTRON SOURCES. Ruby, L.; Rechen, J. B. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 53: 290-2(1967). (UCRL-17431).

Activation detectors employing the $^{207}Pb(n,n')^{207}Pb^{m}$ and the $^{90}Zr(n,n')^{90}Zr^{m}$ reactions have been calibrated for 2.50-MeV neutrons. The calibration was affected by saturating the activities with neutrons from an accelerator employing the $^{2}H(d,n)^{3}He$ reaction at 200 keV. The neutron production rate was calculated from the measured proton production rate due to the associated $^{2}H(d,p)^{3}H$ reaction. The results show that the Zr detector is slightly more efficient than the Pb detector, but that neither is useful for 2.50-MeV pulsed neutron sources yielding less than about 2×10^{7} neutrons per pulse. (auth)

36386 A COMPACT CHERENKOV COUNTER FOR DETECTING ELECTRONS. Culligan, G.; Quirk, T. W. (Oxford Univ.). Nucl. Instrum. Methods, 53: 261-5(1967).

A compact gas Cherenkov counter for detecting electrons is described. The counter is 0.017 radiation lengths thick along the beam direction with an efficiency greater than 0.95 when subtending a solid angle at the electron source of 0.02 of 4π. (auth)

36387 HIGHLY LOCALIZED BRIGHT TRACKS IN HELIUM-FILLED STREAMER CHAMBER. Falomkin, I. V.; Kulyukin, M. M.; Pontecorvo, G. B.; Sherbakov, Yu. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods, 53: 266-72(1967).

A helium-filled streamer chamber is described in which highly localized particle tracks are observed. Such operating conditions are achieved by using small amounts of admixtures (fractions of a percent) affecting the mechanism of the electrical discharge in the main gas (helium). The high voltage pulse is shaped by the discharge within the chamber itself. The average track width in the electric field direction is 1-2 mm, and the light output is sufficient for photographing on a film with a sensitivity $S_{0,88}$ = 1000 units GOST, USSR, through an objective of f/5.6. Data on the discharge in helium are also reported. The electric field gradient was varied between 12.5 and 25 kV/cm. (auth)

36388 MOESSBAUER SCATTERING WITH EFFICIENT GEOMETRY. Hershkowitz, N.; Walker, J. C. (Johns Hopkins Univ., Baltimore). Nucl. Instrum. Methods, 53: 273-6(1967).

A new Mössbauer scattering technique is described in which the x-rays following internal conversion of resonantly absorbed gamma-rays are detected. A simple forward-scattering geometry is used. This allows the scattered x-rays to be detected in a solid angle of up to 2π. For very thin scatterers, this technique is shown to be more efficient than the usual method of scattering and absorption. Corrections for thick scatterers are discussed. (auth)

36389 NONINJECTING BACK-CONTACTS IN SURFACE BARRIER SILICON DETECTORS. Fabri, G.; Nasini, M.; Redaelli, G. (CISE, Milan). Nucl. Instrum. Methods, 53: 337-8 (1967).

A simple method to prepare back-contracts with good ohmic characteristics in surface-barrier-detectors is described. With the detectors so prepared (n-type silicon with resistivity range 350-30 k$\Omega \cdot$cm) no distortion was observed in particle spectra, at low bias and temperature. (auth)

36390 QUANTITATIVE EXPLANATION AND PRECISE MEASUREMENT OF THE PULSE HEIGHT SHIFT ASSOCIATED WITH NUCLEAR REACTION PEAKS IN SOLID STATE DETECTORS. Kraushaar, J. J.; Ristinen, R. A.; Smythe, R. (Univ. of Colorado, Boulder). Phys. Lett., 25B: 13-18(July 24, 1967).

Nuclear interactions that take place in a Li-drifted Si detector were observed with an incident beam of 15-MeV protons. The energy and intensity of a number of escape peaks are enumerated. A calculation was carried out to predict these quantities for the escape peak due to inelastic scattering from the 1.77 MeV state of ^{28}Si and good agreement was found with the experimental results. (auth)

36391 STUDY ON THE DEPENDENCE OF SOME G-M COUNTER PARAMETERS ON THE ANODE CURRENT PASSAGE STRENGTH. Bonchev, T.; Aneva, N. (Sofia Univ.). Compt. Rend. Acad. Bulg. Sci., 20: 273-6(1967).

Preliminary studies are presented on the effects of the anode current, the ignition voltage, and the intensity of light impulse during discharging for different concentrations of quenching gases and a different total gas pressure in the performance of G-M counters. (B.G.D.)

36392 CALCULATION OF AMPLITUDE DISTRIBUTIONS IN MEASUREMENTS OF GAMMA SPECTROMETRY MADE WITH THE AID OF GERMANIUM DETECTORS. Gonidec, J. P.; Walter, G.; Coche, A. (Centre de Recherches Nucleaires, Strasbourg). Nucl. Instrum. Methods, 53: 185-91(1967). (In French).

Taking advantage of the good energy resolution and linearity of lithium-drifted germanium detectors, a method is described for the calculation of pulse height distributions observed with these spectrometers for monoenergetic γ rays. This discussion includes the main types of interactions: photoelectric, single and double Compton effects for incident photons and for radiations scattered from surrounding materials. The resulting calculated gamma ray shapes are compared with experimental spectra, the detector considered was a coaxial device with a sensitive volume of 20 cm^3. (auth)

36393 MEASUREMENT OF NEUTRON FLUX FOR RADIATION. Alcala Ruiz, F.; Montes Ponce de Leon, J. An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 233-9(July-Aug. 1967). (In Spanish).

A self-powered neutron detector has been developed in order to study the neutron flux in the core of the JEN-1 reactor. It consists of a stainless steel tube as a collector and a foil of ^{103}Rh as emitter. Its characteristics and reliability were determined for different operational conditions. (auth)

36394 GAMMA SPECTROMETRIC EQUIPMENT. Campos, J.; Butragueno, J. L. (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 247-51(July-Aug. 1967). (In Spanish).

A gamma spectrometer is described which consists of an amplifier, a single-channel analyzer, and a ratemeter. Simple circuitry ensures reliability. Results for ^{226}Ra and circuit schematics are given. (auth)

36395 ALPHA PARTICULATE AIR MONITOR /Q-2891/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1466).

3 drawings.

An α particulate air monitor which employs two Amperex 18506 Geiger-Mueller tubes is described. The monitor is contained in a stainless steel case shielded on the sides and base with lead. The two G-M tubes are separated by a stainless steel wire spring. (For details see TID-4100 Suppl. 41) (F.S.)

36396 HOMOGENEITY SCANNER CONTROL SYSTEM /Q-2813/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1632).

2 drawings.

A control system for the laboratory model of the homogeneity scanner used in the evaluation of fuel rods or plates is described. The scanner employs industrial x-ray equipment for the radiation source and a Na(Tl) crystal and a photomultiplier tube for the radiation detector (See CAPE-1136). The system controls an audible alarm system and three pneumatic printers located on the scanning table. Two printers print out positive spots. One prints in black and one in green ink. Negative spots, indicating no fuel, print in blue ink. (For details see TID-4100 Suppl. 41) (F.S.)

36397 SILICON DIODE ALPHA SOLUTION MONITOR /Q-2930/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1609).

1 drawing.

A silicon diode monitor used to monitor solutions containing α particles is described. The monitor consists of a polypropylene cell; stainless steel shield, backup plate, cap, washer, plate, a neoprene gasket, an aluminized Mylar gasket, and the silicon diode. (For details see TID-4100 Suppl. 41) (F.S.)

36398 F.E.T. PREAMPLIFIER FOR BF_3 DETECTOR /Q-2876/ (Engineering Materials). (Oak Ridge National Laboratory, Tenn.). (CAPE-1467).

2 drawings.

A field-effect transistor preamplifier is described which is used with a BF_3 detector. The detector and preamplifiers are housed together in a thick Cu container. The preamplifier obtains a high signal-to-noise ratio, is voltage sensitive, and provides a signal gain of 17. Direct coupling prevents bias-level

shifts at high count rates. The equivalent noise voltage for the preamplifier is ~ 4 nV/cycle and the bandwidth is 3.5 megahertz. (For details see TID-4100 Suppl. 40) (F.S.)

36399 REM RESPONDING PORTABLE NEUTRON SURVEY METER (Engineering Materials). (Brookhaven National Lab., Upton, N. Y.). (CAPE-1601).

1 drawing.

A portable, battery-operated fast neutron monitor is described which employs a polyethylene loaded proportional counter and reads directly in biologically equivalent units for neutrons from 0.1 MeV to over 15 MeV on eight scales ranging from 2 mrem/hr to 6000 mrem/hr. The proportional counter contains a mixture of methane, nitrogen, and argon. Input pulses are integrated for electronically determined time intervals on the lower ranges, while on the higher ranges, a ratemeter mode of operation is employed. All electronics require only 25 mW of power permitting 500 hrs of continuous operation from a small 7 V mercury battery. Electronic voltage regulation and the use of field-effect transistors provide stability of calibration. This equipment was developed for use with reactors and accelerators. (For details see TID-4100 Suppl. 40) (F.S.)

36400 FISSION CHAMBER MODEL VI /Q-2851/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1606).

4 drawings.

A parallel plate fission chamber is described which is used in the measurement of neutron capture cross sections and fission cross sections of fissile isotopes with relatively high α activity. The chamber contains 21 plates each 3 in. in dia with a ^{233}U plated area of 45.5 cm^2. For other related parallel plate fission chambers see CAPES-1350, 1375 and 1398). (For details see TID-4100 Suppl. 41) (F.S.)

36401 HIGH RESOLUTION SPECTROMETER (Engineering Materials). (Brookhaven National Lab., Upton, N. Y.). (CAPE-1623).

30 drawings.

A high resolution spectrometer is described which was designed to be used in nuclear structure studies. The spectrometer uses digital wire spark chambers operating at 3 in. Hg absolute. Two H magnets (18 in. × 36 in.) bend the 1 BeV proton beam 18°. A low pressure tank consists of cylindrical fore and aft sections 19 in. in dia. Large boxes contain spark planes, and a rectangular duct $5\frac{1}{2}$ in. high by 17 in. wide fits through the magnet gaps. End windows are fabricated of 0.010 in. mylar sheet. The solid angle, at 1.7 BeV/c incident proton momentum, was about 0.73×10^{-4} steradians; the momentum aperture, $\Delta P/P$ was ±0.03. (For details see TID-4100 Suppl. 41) (F.S.)

36402 PORTABLE BODY MONITOR: SOME DESIGN CHARACTERISTICS. Ahmed, Jasim uddin. Ann Arbor, Mich., Univ. of Michigan, 1966. 143p.

Thesis.

A study was conducted to determine if a portable body monitor could be designed to measure in vivo one tenth of the maximum permissible body burdens of the γ emitting isotopes commonly encountered as internal contaminants in radiation workers. One major criterion was to avoid, if possible, heavy shielding so that measurements could be made in any laboratory room. The body monitor was to be portable if the whole unit was movable or its sub-units such as the detector, detector shield, electric typewriter, high voltage supply, and pulse height analyzer were movable by one man. The investigation comprised both theoretical and experimental determination of the minimum detectable activities of various γ emitters in the body. The theoretical minimum detectable activities are presented for ^{140}Ba, ^{141}Ce, ^{144}Ce, ^{60}Co, ^{137}Cs, ^{59}Fe, ^{131}I, ^{22}Na, ^{24}Na, ^{103}Ru, ^{106}Ru, ^{125}Sb, ^{132}Te, ^{65}Zn, and ^{95}Zn. These were calculated considering the γ emitters to be deposited in the critical organs in a standard man. The standard man was assumed seated in front of the probe at a chest-probe distance of 16 cm. From the theoretical calculations, a 5″ × 4″ NaI(Tl) crystal was found to be a suitable detector for the portable body monitor. Also the minimum detectable activities of the above γ emitters, except ^{144}Ce, were less than one tenth of the maximum permissible body burdens. The experimental minimum detectable activities of the above γ emitters are also presented. These were determined by making measurements with a 5″ × 4″ NaI(Tl) crystal using a standard-man phantom. For measurements, γ sources, point or distributed, were put inside the lung or stomach of the phantom that was placed in a seated position in front of the probe at a chest-probe distance of 16 cm. The sources used for measurements were standardized with a 3″ × 3″ NaI(Tl) well counter. The phantom measurements verified the theoretical minimum detectable activities. Also, when extrapolated from phantom measurements to human, the minimum detectable activities of the above γ emitters, except ^{144}Ce, were less than or equal to one tenth of the maximum permissible body burdens. All of the above results suggested that a 5″ × 4″ Na(Tl) crystal was the minimum size to be used in the portable body monitor. (Disser. Abstr.)

Radiation Dosimeters

Refer also to abstracts 36575 and 36589.

36403 (USNRDL-TR-67-66) RADIOPHOTOLUMINESCENCE SPECTRA OF SILVER-ACTIVATED DOSIMETER GLASSES. Becker, K.; McQuilling, D. W. (Naval Radiological Defense Lab., San Francisco, Calif.). June 23, 1967. 29p. CFSTI.

The radiophotoluminescence (RPL) spectra of silver-activated phosphate glasses of different compositions under 365 mμ excitation were measured in the 400 to 750 mμ range. The apparatus, specially designed for this type of measurement, uses a red-sensitive photomultiplier tube and permits comparison of the relative RPL intensity with the known output of a NBS-calibrated lamp for each wavelength interval. Shape and maximum of the RPL spectrum depend on the type of photomultiplier tube, if no corrections for the photomultiplier spectral response are made. After corrections, a steep RPL increase above ca. 500 mμ, spectral radiant intensity maxima between 615 (French C.E.C. glass) and 640 mμ (DT-60 glass) depending on the glass composition, and a slow increase in the red have been observed. For a constant glass base composition, the Ag concentration of from 0.5% to 5% did not affect the spectrum. Also the dose level and the degree of the RPL build-up after exposure had only minor influence on the spectrum. During thermal annealing, a RPL increase in the blue has been observed. After a megarad exposure, a permanent RPL which could not be annealed has been found. Some further experiments are suggested. (auth)

36404 AUTOMATIC INSTRUMENT FOR MEASURING THE LIGHT TRANSMISSION OF PERSONNEL MONITORING FILMS. Larson, S. (CERN, Geneva). Health Phys., 13: 857-60(Aug. 1967).

A densitometer was constructed which automatically measures the transmission of light through seven points, or through only one point, on gamma films used for personnel monitoring. The data are automatically punched out on cards. Of particular interest is the use of flexible light guides, which offers a simplified mechanical construction and more favourable optical conditions. A printing summary punch with two programme drums is used. The second drum controls the position of a light distributor which, via light guides, illuminates different points on the film. This offers the advantage that the scanning programme can easily be changed, and the second drum makes it easy to synchronize the automatic operation, which results in a minimum of electronics. (auth) (UK)

36405 THE EFFECTS OF FAST NEUTRON EXPOSURE ON THE ^{7}LiF THERMOLUMINESCENT RESPONSE TO GAMMA RAYS. Oltman, B. G. (Argonne National Lab., Ill.); Kastner, J.; Tedeschi, P.; Beggs, J. N. Health Phys., 13: 918-19(Aug. 1967).

There is evidence that neutron exposure may affect the gamma ray response of LiF. A definitive experiment is described with a view to determining whether such an effect does, in fact, exist. A large number of ^{7}LiF-filled polyethylene tubing dosimeters, annealed at 400°C for 1 hour and then at 85°C for 16 hours, were exposed to fast neutrons from the $^{7}Li(p,n)^{7}Be$ reaction using a 4 MeV Van de Graaff, some of the dosimeters having previously been exposed to ^{60}Co gamma radiation, and some simultaneously ^{60}Co gamma irradiated. The fast neutrons were of energies 0.1, 0.26, and 1.0 MeV. Gamma rays of 0.48 MeV accompany the foregoing nuclear reaction; these were monitored with a hexafluorobenzene scintillator. In order to obtain a conversion factor to relate the scintillator readings to LiF thermoluminescence, intercomparison of the detector with the LiF dosimeters was made. Results are tabulated. The observed percentage drop in thermoluminescent response appeared to be independent of whether neutron exposure occurred simultaneous with or following gamma irradiation. The percentage drop was also independent of total exposure and energy. It is interesting to speculate as to the mechanism which could account for an effect which is independent of neutron energy at least up to 1 MeV. It seems reasonable to conclude that such neutrons can only introduce lattice vibrations similar to the thermal effect of the heater. It is concluded that LiF should not be used in the presence of fast neutrons to monitor gamma radiation without careful precautions. (UK)

36406 HIGH DOSE RESPONSE OF GLASS ROD DOSIMETERS IRRADIATED AT TEMPERATURES UP TO 250°C. Bradshaw, R. L.; Beck, W. L.; Dickson, H. W.; Hanson, W. F. (Oak

Ridge National Lab., Tenn.). Contract W-7405-eng-26. Health Phys., 13: 910-15(Aug. 1967). (ORNL-P-2658).

It was found that Bausch and Lomb low-Z glass rod dosimeters with post-irradiation heat treatment are usable at doses up to about 3×10^5 rads and exposure temperatures up to 250°C. Post-irradiation heat treatment of 1 hr at 325°C gives a calibration curve which is essentially the same for exposure temperatures from 150° to 250°C. The calibration curve for exposures at 25°C is about 25% lower than the elevated temperature curve. The photoluminescence of exposed rods can be erased by holding them at 500°C for 1 hr. Of the rods so treated 80% were reduced to background readings. These rods can then be reused with the same post-irradiation heat-treatment calibration curve with somewhat less accuracy than new rods. The long-term stability of readings depends on several variables, including the exposure temperature and the post-irradiation heat treatment. The length of the exposure period does not appear to be important for periods from 1 min up to 1 hr, but there is some indication that it may be important for long exposures at elevated temperatures. (auth) (UK)

36407 SELF-DEVELOPING FILM DOSIMETER SYSTEMS. Brown, William H.; Post, Roy G.; Wacks, Morton E. (Univ. of Arizona, Tucson). Trans. Amer. Nucl. Soc., 10: 55(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36408 VERSATILE CHEMICAL DOSIMETRY SYSTEMS FOR RADIATION PROCESSING. McLaughlin, William L. (National Bureau of Standards, Washington, D. C.); Chalkley, Lyman. Trans. Amer. Nucl. Soc., 10: 52(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36409 CHEMICAL DOSIMETRY WITH CHELATED FERRIC INDICATORS. Benn, Edward; Post, Roy G.; Wacks, Morton E. (Univ. of Arizona, Tucson). Trans. Amer. Nucl. Soc., 10: 53 (June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36410 EVALUATION OF PERSPEX HX AS A GAMMA-RAY DOSIMETRY MATERIAL. Rizzo, F. X.; Cunningham, G.; Galanter, L. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 10: 53-4(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36411 THERMAL-NEUTRON FLUENCE MEASUREMENTS WITH ^{6}LiF THERMOLUMINESCENT MICRODOSIMETERS. Warman, E. A. (Aerojet-General Corp., Sacramento, Calif.); Seibold, J. R. Trans. Amer. Nucl. Soc., 10: 311-12(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36412 RADIATION DOSIMETRY FOR MANNED SPACE-FLIGHT. Richmond, Robert G.; Davis, William G.; Lill, Joseph C. (Manned Spacecraft Center, Houston, Tex.). Trans. Amer. Nucl. Soc., 10: 389(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36413 FLUORO-GLASS DOSIMETER. A NEW HIGH-PERFORMANCE FLUORO-GLASS DOSIMETER ENABLES 10-mR MEASUREMENT. Tsuruoka, Mizuo; Yokota, Yukio (Tokyo Shibaura Electric Co., Ltd.). Toshiba Rev., Int. Ed., No. 28, 26-30(Oct.-Dec. 1966).

Application of radiophotoluminescent glass to a dosimeter dates back many years. Recently the performance of this glass has been further improved with the development of FD-3 and FD-4 glasses. Meanwhile, the conventional instruments FGD-3B and FD-5 have been improved to FGD-6, enabling measurement up to 10 mR. There is now available even a reference glass which possesses the same temperature coefficient as the radiophotoluminescent glass. (auth)

36414 GAMMA-ACTIVATION DOSIMETER. Abrams, I. A.; Pelekis, L. L. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 2, 3-5(1967). (In Russian).

A method for measuring large dose rates of gamma rays with a gamma-activation dosimeter was developed. The dosimeter is based on the short lived isomer activation in inelastic gamma-ray scattering. (auth)

Radiometric Instruments

Refer also to abstracts 36120 and 36128.

36415 (ORO-3224-10) SOME EXAMPLES OF ORE AND ALLOY ANALYSIS USING A MULTIPURPOSE PORTABLE ANALYZER. Rhodes, J. R. (Texas Nuclear Corp., Austin). Mar. 27, 1967. Contract AT(40-1)-3224. 32p. (CONF-670321-2). DTIE.

From 2nd Symposium on Low Energy X- and Gamma-Ray Sources and Applications, Austin, Tex.

A portable, battery-operated X-ray fluorescence analyzer is described consisting of a NaI(Tl) scintillation counter probe and an electronic unit with a single channel pulse height analyzer and reversible scaler. Radioisotope X-ray sources are used for excitation of the sample and, where necessary, balanced filters for resolution of neighboring characteristic X-rays. Preliminary results are reported for determination of sulphur in coal, calcium and iron in cement raw mix and copper in copper ores. (auth)

36416 RADIOISOTOPE GAUGE FOR MONITORING SUSPENDED SEDIMENT IN RIVERS AND STREAMS. Ziegler, C. A.; Papadopoulos, J.; Sellers, Bach (Parametrics, Inc., Waltham, Mass.). Int. J. Appl. Radiat. Isotop., 18: 585-93(Aug. 1967).

The problem of determining the amount of water-carried suspended sediment is of increasing importance in areas concerned with agriculture, navigation and water conservation. Conventional point sampling methods have proved inadequate to meet current hydrology planning needs because short term concentration excursions cannot be monitored. In order to satisfy the need for a self-powered, continuous monitoring system, a gauge based on the use of radiation from a radioisotope source, having the capability of continuously measuring sediment concentration over a range of 1000–50,000 ppM was designed, developed and tested. The system is capable of operating and recording data unattended for a period of 7½ days on internal power, thus constituting a completely automatic monitoring system. The theory of operation, error analysis, calibration methods, operating procedures, and test results, are presented. (auth) (UK)

36417 EFFECTS OF NEUTRON SOURCE TYPE ON SOIL MOISTURE MEASUREMENT. Goldberg, Irving (Dept. of Water Resources, Sacramento, Calif.); MacGillivray, Norman A.; Ziemer, Robert R. Trans. Amer. Nucl. Soc., 10: 20-1(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36418 SOIL DENSITY MEASUREMENTS WITH GAMMA RAYS. Helbig, Wolfgang; Beer, Manfred (Institut fuer Mechanisierung der Landwirtschaft Potsdam-Bornim, Ger.). Arch. Landtech., 5: 182-203(1965). (In German).

The theoretical and practical aspects of soil density measurements with γ-ray sources are discussed, and construction and operation of two soil density probes utilizing ^{60}Co are described. The use of radioisotopes in agricultural research is considered. With the two ^{60}Co-equipped instruments (DS-1 and DS-2) which are described, measurements could be made at soil depths varying from 7 to 42 cm. With DS-1, a forked probe, the error in measurements varied from 2 to 3.5%. A twin borer was used to make the holes in soil for this instrument. The DS-2 sectional probe was used to record density of earth walls, up to 35 cm thick. Equations were derived as a basis for the measurements, and the relative advantages and disadvantages of ^{60}Co and ^{137}Cs as sources were discussed. Safety features of the instruments are considered. With DS-1 the dose rate at a 1-m distance was ~2 mRem/hr without interposition of absorbing substances. In actual use it was found, by film dosimetry, that the operator received less than 5 mRem/month. (BBB)

36419 USE OF A RADIOACTIVE BETA SOURCE TO MONITOR HIGH AIRBORNE-DUST CONCENTRATIONS. Williams, A. J. (Safety in Mines Research Establishment, Harpur Hill, Eng.). J. Sci. Instrum., 44: 562-3(July 1967).

A ^{90}Sr–^{90}Yt 5 mCi source was used to measure coal dust concentrations in air up to 2 mg cm^{-3} as part of a study of dust explosions. This basically simple method offers several advantages over other available means of continuously measuring high dust concentrations but requires a preliminary calibration. (auth) (UK)

Miscellaneous Instruments and Components

Refer also to abstracts 36109, 36110, 36143, 36211–36214, 36269, 36270, 36331, 36781, 36789, and 38127.

36420 (APDA-191) DELAY LINE-TYPE LEVEL SENSOR FOR HIGH-TEMPERATURE LIQUID SODIUM. Ziniuk, M. A. (Atomic Power Development Associates, Inc., Detroit, Mich.). July 1966. 47p.

A coil-type delay line suitably encased in a protective sheath

can function as a level sensor in fluid alkali metals with many potential advantages over conventional sensors. The feasibility of the delay line level sensor concept has been demonstrated at Atomic Power Development Associates, Inc., (APDA) by bench tests on several short-length experimental delay lines and by in-sodium tests to 800 F on an 8-½-foot sensor unit. (auth)

36421 (AWRE-O-94/64) THE CALIBRATION OF CASCADE IMPACTORS. Operation ROLLER COASTER. Thomas, D. M. (Atomic Weapons Research Establishment, Aldermaston (England)). [Sept. 10, 1964]. 15p. Dep.

Calibration parameters for the Casella and Andersen impactors were agreed between the US and UK parts of the Roller Coaster team: the parameters most suited for use in evaluating the data are the Characteristic Diameters, agreed values of these for both instruments and of the M.M.D.'s for the Casella are given. Neither instrument will necessarily give a correct measure of the airborne concentration of the larger particles (greater than about 50 μ) because of orifice effects and in addition there are losses at the first jet plates of the Andersen instrument. In a comparison of the Casella and Andersen data and the estimation of a complete size distribution of the airborne material, other information, such as that obtained with the cylindrical collectors, must be taken into account. (auth)

36422 (AWRE-SLE-1/62) HIGH-POWER PUSH-PULL TRANSISTOR AMPLIFIER. Bennett, R. F. C. (Atomic Weapons Research Establishment, Aldermaston (England)). [nd]. 21p. Dep.

In the course of designing a transistor power amplifier to drive a 75 kVA vibrator a pilot model to drive a smaller vibrator was developed. Operating in class A it is capable of delivering 1 kW into a resistive load of 10 Ω and the frequency response is sensibly flat from 2 c/s to 4 kc/s. Details are given of the method of handling the necessary power by coupling together many OC28 transistors. Possible improvements in design are discussed. (auth)

36423 (DP-1119) SOLID-STATE CIRCUIT FOR A REACTOR PERIOD SIMULATOR. Byrd, J. S. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). July 1967. Contract AT(07-2)-1. 8p. Dep. CFSTI.

A solid-state circuit was constructed that provides an exponentially rising or falling electric current from 10^{-12} to 10^{-4} amp. This circuit is used in a convenient and reliable period simulator that tests the electronic response of instruments monitoring the neutron flux level in a nuclear reactor. (auth)

36424 (IDO-17225) WIDE RANGE TIME TO PULSE HEIGHT CONVERTER USING A TRANSISTOR IN THE AVALANCHE SWITCHING MODE. Hofhine, Paul A. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). May 1967. Contract AT(10-1)-205. 26p. Dep. CFSTI.

A solid-state time-to-pulse-height converter is described whose output pulse height is proportional to the time between the input pulse and a reference pulse. The instrument utilizes the sweep voltage from an oscilloscope to control the output pulse amplitude. This provides a wide range of values for the maximum or full-scale time input. A deviation from linearity of less than ±¼ percent of the maximum output has been achieved. The unit incorporates a diode sampling gate, driven by an avalanche transistor, to achieve a sampling time of less than a nanosecond. (auth)

36425 (IPP-4/43) 15 kV TRIGGERGERAET MIT FUNKENSTRECKE. (A 15 kV Trigger-Generator With Spark Gap). Kunze, R. C.; Mark, E. v. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). June 1967. 11p. (In German). Dep.

In the field of power discharges, for many applications (e.g., triggering of spark gaps or kerr-cells), fast rising, low jitter high voltage pulses are needed. A pulse generator which satisfies the above requirements and, in addition, is unaffected by voltage transients and has a long life is described. (auth)

36426 (MLM-1341) WATER BATH CALORIMETER NO. 94. Birden, J. H.; Dudley, W. A.; Jordan, K. C.; Nutter, J. D.; O'Hara, F. A.; Otto, G. W. (Mound Lab., Miamisburg, Ohio). July 30, 1966. Contract AT(33-1)-Gen-53. 23p. Dep. CFSTI.

An isothermal water bath calorimeter capable of measuring large (volume) heat sources is described. An internal four-terminal calibration heater with associated power supplies and accurate measuring console make it an absolute system. Due to its basic engineering design, the percentage accuracy and precision errors should be approximately constant on all power ranges. A probable error of 0.104% for a single observation was obtained from nine observations of a standard 3.1893-watt heat source; a conservative overall value would be 0.25%. The grand mean value was 0.017% higher than the standard value. The useful measuring range is from 3 to 150 watts. (auth)

36427 (NAA-SR-12118) CHARACTERISTICS OF TWO COMMERCIAL HIGH-TEMPERATURE ELECTRIC RESISTANCE STRAIN GAGES. Lemcoe, M. M. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). Aug. 15, 1967. Contract AT(04-3)-700. 103p. Dep. CFSTI.

A technical evaluation of two types of commercially available high-temperature electric resistance strain gages is reported. These gages, the BLH Type HT 1212-5A and Microdot Type SG420, were selected for evaluation because of the need for more reliable electric resistance strain gages for high-temperature stress or strain measurements, and process instrumentation for use in the temperature range of 900 to 1200°F. The BLH gage is rated by the manufacturer as a 1000 to 1200°F gage; the Microdot gage is rated as a 900°F gage. Instrumentation of this type is needed to determine or ensure component structural integrity and overall system reliability of fast breeder reactors. These two types of gages were considered to be the most promising of the commercial high-temperature gages for sodium component loop testing. Other types of commercial gages were ruled out because of their temperature limitations, their inability to be properly installed or cured in the field, and other factors which are discussed. The results of this evaluation indicate that the BLH gage is not suitable as a 1200°F gage for measurements on austenitic stainless steel components which are subjected to both steady-state and transient temperature conditions and heating rates in excess of 5°F/sec. The Microdot gage, on the other hand, was found satisfactory for use on austenitic stainless steel components for temperatures up to 900°F, under both steady-state and transient conditions, for heating rates up to at least 30°F/sec. It was therefore concluded that, while there are electric resistance strain gages satisfactory for use up to 900°F, there are no suitable commercial gages for use at 1200°F. The results reported, which include a statistical analysis of the data, relate only to the evaluation of the previously mentioned commercial gages. (auth)

36428 (NYO-3622-9) APPLICATIONS OF ULTRASONIC ENERGY: ULTRASONIC INSTRUMENTATION FOR NUCLEAR APPLICATIONS. Bimonthly Progress Report No. 34, April 1, 1967-May 31, 1967. (Aeroprojects, Inc., West Chester, Pa.). June 1967. Contract AT(30-1)-3622. 13p. Dep. CFSTI.

Preliminary incipient-boiling detection tests in a modified molten sodium test cell are being planned, pending the decision to combine such test with a flowmeter evaluation in a dynamic loop. An improved system for readout of incipient boiling is discussed and illustrated herein. (auth)

36429 LUMINESCENCE SPECTROPHOTOMETER FOR POWDERS EXCITED BY PULSED IONIZING RADIATION. Lillicrap, S. C. (Royal Cancer Hospital, Sutton, Eng. Royal Marsden Hospital, Sutton, Eng.). J. Sci. Instrum., 44: 584-6(Aug. 1967).

A simple luminescence spectrophotometer system is described for the observation of emissions in the wavelength range 180-600 nm from microcrystalline powders excited by pulses of ionizing radiation. The samples may be irradiated at selected temperatures between 90°K and room temperature, and in the presence of different gases. The system allows delayed emission measurements to be made from 2 μsec after the irradiation cut-off. (auth) (UK)

36430 USE OF TIME-SHARING COMPUTERS WITH STANDARD NUCLEAR INSTRUMENTS FOR DATA ACQUISITION, ANALYSIS, AND DISPLAY. Carr, Howard E. Jr.; Graham III, W. Waverly (Georgia Inst. of Tech., Atlanta). Trans. Amer. Nucl. Soc., 10: 17-18(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36431 VERSATILE GAMMA-RAY ANALYZER SYSTEM FOR ACTIVATION ANALYSIS. Johnson, Ralph A. (Shell Development Co., Emeryville, Calif.). Trans. Amer. Nucl. Soc., 10: 86(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36432 DELAY-LINE-TYPE LEVEL SENSOR FOR HIGH-TEMPERATURE LIQUID METALS. Ziniuk, M. A. (Atomic Power Development Associates, Inc., Detroit). Trans. Amer. Nucl. Soc., 10: 309(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36433 FUEL-PIN THERMOCOUPLE HOT-ZONE ERRORS AT TEMPERATURES UP TO 2400°C. Knox, A. E.; Popper, G. F. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 309-10(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36434 MEASUREMENT OF THE VISCOSITY OF GASES AND ALKALI METAL VAPORS AT ELEVATED TEMPERATURES WITH THE VIBRATING-WIRE VISCOMETER. Achener, P. Y. (Aerojet-General Corp., San Ramon, Calif.). Trans. Amer. Nucl. Soc., 10: 144-5(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36435 COINCIDENCE/ANTICOINCIDENCE TECHNIQUES IN NUCLEAR INDUSTRIAL PROCESS CONTROL STUDIES. Martin, Troy C.; Williams, G. H.; Ashe, J. B. (Texas Nuclear Corp., Austin). Trans. Amer. Nucl. Soc., 10: 43(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36436 X-RAY DIFFRACTION USING ISOTOPIC SOURCES. Toothacker, William S.; Preuss, Luther E. (Edsel B. Ford Inst. for Medical Research, Detroit, Mich.). Trans. Amer. Nucl. Soc., 10: 73-4(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36437 MEASUREMENT OF AVERAGE FISSION-FRAGMENT ELECTRONIC CHARGE DEPENDENCE ON SOURCE THICKNESS. Linnerud, H. J.; Connolly, T. J.; Sher, R.; Safonov, G. (Stanford Univ., Calif.). Trans. Amer. Nucl. Soc., 10: 70-1(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36438 FABRICATION OF SEMICONDUCTOR DEVICES EMPLOYING TRANSMUTATION DOPING TECHNIQUES. Klahr, Carl N.; Cohen, Melvin S. (Fundamental Methods Associates, Inc., N. Y.). Trans. Amer. Nucl. Soc., 10: 75(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36439 ENERGY-TO-COLOR MODULATION FOR MULTI-ISOTOPE SCANNING. Ben-Porath, Moshe; Clayton, Glenn; Kaplan, Ervin (Veterans Administration Hospital, Hines, Ill.). Trans. Amer. Nucl. Soc., 10: 80-2(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36440 FET OPERATIONAL AMPLIFIERS AS FAST ELECTROMETERS. Wing W. H.; Sanders, T. M. Jr. (Univ. of Michigan, Ann Arbor). Rev. Sci. Instrum., 38: 1341-2(Sept. 1967).

The usefulness of operational amplifiers using field-effect transistors in the input stage in experiments requiring detection of weak transient currents is discussed. The electrometers were built utilizing a relatively inexpensive commercial operational amplifier and a minimal amount of other circuitry. Typical performance obtained is minimum detectable current 5 pA, with a rise time of 10 to 20 μsec. (L.B.S.)

36441 TURBINE DRIVEN ROTATING COIL MAGNETOMETER. Rowe, E. M.; Hicks, J. W.; Bush, G. E. (Midwestern Universities Research Association, Stoughton, Wis.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 478-81 (June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

A rotating coil magnetometer which utilizes an air turbine to turn the coil was developed. Since the turbine rotor forms the mount for the coil, there are no shafts or gears. Thus, this magnetometer may be used to measure fields in locations inaccessible to more conventional rotating coil devices. The precision of the suspension of the turbine and the lack of mechanical vibration make it possible to measure transverse field components of the order of one milligauss in a field of one kilogauss. The sensitivity of the magnetometer is made independent of the rotational speed of the coil through the use of an electronic integrator. The coil and integrator circuit is used in conjunction with another system which allows the determination of the direction of the magnetic field being measured relative to a predetermined direction. (auth)

36442 COMPLEX OF SYSTEMS FOR MEASURING THE CHARACTERISTICS AND STABILIZATION OF STATIC MAGNETIC FIELDS. Denisov, Yu. N. (Joint Inst. for Nuclear Research, Dubna, USSR). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 482-6(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

Several devices and systems used at the Laboratory of Nuclear Problems of the Joint Institute for Nuclear Research for measuring inhomogeneous magnetic fields from 1 mT to 2.5 T (10 to 25,000 gauss) to an accuracy of 0.1 to 0.01% are described. (auth)

36443 SUPERCONDUCTING PARAMETRIC AMPLIFIER FOR THE MEASUREMENT OF SMALL dc VOLTAGES. Ries, Roger P.; Satterthwaite, C. B. (Univ. of Illinois, Urbana). Rev. Sci. Instrum., 38: 1203-9(Sept. 1967).

A new device capable of measuring minute dc voltages is described, and a simple theory which describes the operation and predicts the performance is presented. Experimental amplifiers have demonstrated dc sensitivities which closely approach the maximum attainable by any device. Their performance characteristics agree satisfactorily with the theory. Sensitivities of 4×10^{-14} V with a source resistance of 4×10^{-7} Ω and a time constant of ≈1 sec have been obtained at 4.2°K. The ultimate sensitivity appears to be limited only by the noise present in the source itself. (auth)

36444 REVERSIBLE PRECOUNTER FOR PHOTON COUNTING. Helman, W. P.; Schutt, D. W. (Univ. of Notre Dame, Ind.). Rev. Sci. Instrum., 38: 1286-8(Sept. 1967). (COO-38-523).

The conversion of a Cary model 14 spectrofluorimeter to photon counting with automatic background noise subtraction is described. For purposes of economy and rapid conversion, an existing events counter-timer was used and a reversible precounter made to accomplish the noise subtraction. (auth)

36445 SIMULATION OF NUCLEONIC CASCADES AS A MEANS OF STUDYING FLUCTUATIONS. Linsley, John (Massachusetts Inst. of Tech., Cambridge). Rev. Sci. Instrum., 38: 1268-71 (Sept. 1967).

A method is described for generating electrical signals with waveform analogous to the longitudinal distribution of particles in fluctuating nucleonic cascades. Measurements carried out on the signals are equivalent to Monte Carlo calculations for the cascades. Results are applicable in the study of cosmic ray air showers. Signal fluctuations arise from fluctuations in quantities that represent atmospheric level and inelasticity of the dominant nucleon–nucleus interactions. (auth).

36446 SERIES INTERFEROMETER FOR THE DIAGNOSIS OF A LARGE DIAMETER THETA-PINCH. De Angelis, A.; Martellucci, S. (EURATOM–CNEN, Frascati, Italy). Rev. Sci. Instrum., 38: 1255-9(Sept. 1967).

An optical interferometer, particularly suitable for the refractive diagnosis of large dimension plasmas is described. Throughout the work, the theory of the instrument is revised in view of plasma applications. Subsequently, a detailed description of a 12 m long series interferometer working on a large diameter theta-pinch is given. During the experiment, both a Q-switched ruby laser and a pulsed arc lamp have been used. (auth)

36447 SILICON-CONTROLLED RECTIFIER CIRCUITRY FOR PRODUCING PULSED MAGNETIC FIELDS. Rothwarf, F.; Bateman, C. O.; Ford, D.; Milke, P. (Frankford Arsenal, Philadelphia). Rev. Sci. Instrum., 38: 1241-4(Sept. 1967).

A switching circuit using a high power silicon-controlled rectifier to discharge a high energy (5kJ), low voltage (450 V) capacitor bank into pulse coils immersed in liquid helium is described. A free-wheeling diode assures that the pulses remain unidirectional. The circuit has successfully operated with inductance-resistance-capacitance (LRC) combinations yielding pulses having rise times τ_R and decay times τ_D in the ranges 0.80 msec $\leq \tau_R \leq$ 0.25 sec and 2.2 msec $\leq \tau_D \leq$ 1.2 sec, respectively. Another SCR is used to shunt unwanted capacitor energy to an auxiliary circuit at any desired time during the pulse duration. This function is used to protect the pulse coils from overheating and to conserve liquid helium. The use of special, fixed-geometry copper coils is described which enables one to obtain initial rates of change of the applied magnetic field $\dot{H}_0$ which varied over many orders of magnitude ($10^2 < \dot{H}_0 < 10^8$ Oe/sec). The circuit, while generally useful in most solid-state studies requiring pulsed-magnetic fields, was used to study flux-jumping, rate effects, and critical currents in tubes and wires made of type II superconducting materials. Some of these experiments are described. (auth)

36448 MEASUREMENT OF TIME DIFFERENCES IN THE RANGE MILLI- TO PICOSECONDS. Hauser, U.; Knissel, G.; Moritz, J.; Schneider, U. (Univ., Heidelberg). Rev. Sci. Instrum., 38: 1220-4(Sept. 1967).

The application of the internal electronics of a commercial sampling oscilloscope, modified by a few additional components which do not interfere with the normal functions of the oscilloscope, as a very fast time-to-amplitude converter for measurements of short time differences is described. The electronic modifications and their functions are reported. The electronic time resolution has a FWHM of 3.2×10^{-11} sec, a slope decay t_b of 5×10^{-12} sec, and certainly can be improved. The range of measurable time differences lies between some picoseconds and some milliseconds. (auth)

36449 USE OF POLYA STATISTICS IN INVESTIGATIONS OF SECONDARY ELECTRON YIELDS FROM TARGET SURFACES. Dietz, L. A. (General Electric Co., Schenectady, N. Y.). Rev. Sci. Instrum., 38: 1332-3(Sept. 1967). (KAPL-P-3318).

The potential usefulness of a Polya statistical model in diagnostic studies of secondary electron yields from target surfaces is pointed out. A generalized version of Prescott's model (Nucl. Instr. Methods, 39: 173(1966)) was used to study the single electron response of a porous KCl transmission dynode. (L.B.S.)

36450 UNDERSIRABLE EFFECTS OF COOLING PHOTOMULTIPLIERS. Young, Andrew T. (Univ. of Texas, Austin). Rev. Sci. Instrum., 38: 1336(Sept. 1967).

Comments are made concerning the effects of cooling on the signal-to-noise ratio at 700 mμ from Lipsett's data for an EMI 6256 photomultiplier (Rev. Sci. Instr., 38: 278(1967)). (L.B.S.)

36451 A FAST PULSE SHAPER EMPLOYING A TUNNEL DIODE AND THE ASZ 23 AVALANCHE TRANSISTOR. Kalisz, Jozef (Inst. of Nuclear Research, Polish Academy of Sciences, Swierk). Nukleonika, 12: 457-8(1967).

A transistorized circuit was developed as an input shaper in a fast time converter. The circuit employed a tunnel diode and the ASZ 23 avalanche transistor. (B.G.D.)

36452 TIMING SINGLE CHANNEL PULSE HEIGHT ANALYZER. Nadachowski, Michal (Inst. of Nuclear Research, Polish Academy of Sciences, Swierk). Nukleonika, 12: 451-6(1967).

The transistorized single channel pulse height analyzer with a fixed delay of the output pulse is described. The delay may be adjusted from 0.5 μsec to 1 μsec. The amplitude range of the analyzer is 200 mV to 10 V. The block diagram, some circuit details and characteristics of the analyzer are given. (auth)

36453 PERFORMANCE OF AN ON-STREAM RADIOISOTOPE X-RAY FLUORESCENCE ANALYSER. Carr-Brion, K. G. (Warren Spring Lab., Stevenage, Eng.). Trans. Inst. Mining Met., 76: C94-C100(June 1967).

The performance of a radioisotope x-ray fluorescence slurry analyser operated under laboratory and plant conditions is described. Methods used to correct for variations in the x-ray attenuation coefficients and solid content of slurries are described and the advantages and limitations are discussed. (auth)

36454 GAIN STABILITY IN HIGH-CURRENT PHOTOMULTIPLIERS AT HIGH VARIABLE COUNTING RATES. Gupta, A. K.; Nath, N. (Banaras Hindu Univ., India). Nucl. Instrum. Methods, 53: 352-4(1967).

Variations in the gain of 56AVP photomultiplier tubes are studied by changing the counting rates. It is observed that at high counting rates the gain of a photomultiplier tube appreciably increases with increasing counting rate. The energy resolution of the photomultiplier tube is found to deteriorate at high counting rates. It is found that this gain shift is nearly eliminated by keeping the voltages stabilized for the last two stages of the photomultiplier chain. This also helps in maintaining the energy resolution. (auth)

36455 APPARATUS PERMITTING THE UNIFORM RADIOACTIVATION OF NONHOMOGENEOUS SAMPLES. Perdijon, J. (SAMES, Grenoble, France). Nucl. Instrum. Methods, 53: 335-6 (1967). (In French).

So as to improve the reproducibility of 14 MeV neutron activation analysis, even when the samples are not homogeneous, a device was perfected allowing simultaneous irradiation of the sample and of a standard, while they rotate around the axis of the target and around their respective axis. (auth)

36456 MAGNETIC SPECTROMETER FOR HIGH ENERGY ELECTRON SCATTERING EXPERIMENTS. Bartel, W.; Dudelzak, B.; Krehbiel, H.; McElroy, J. M.; Meyer-Berkhout, U.; Morrison, R. J.; Nguyen-Ngoc, H.; Schmidt, W.; Steffen, K. G.; Weber, G. (DESY, Hamburg. Univ., Hamburg). Nucl. Instrum. Methods, 53: 293-8(1967).

A spectrometer composed of deflecting magnets and magnetic quadrupoles is described which is designed to analyze particles scattered in the angular range 8–35° and at incident energies up to 6 GeV. A momentum discrimination between 0.2 and 0.7%, depending on the scattering angle, was achieved. The performance of the spectrometer for the scattering of 5.275 GeV electrons from protons at 12.5° is described. (auth)

36457 HIGH FREQUENCY MODULATION OF MONOENERGETIC NEUTRONS WITH A QUARTZ PIEZOELECTRIC CRYSTAL. Moyer, M. W.; Parkinson, T. F. (Univ. of Florida, Gainesville). Nucl. Instrum. Methods, 53: 299-304(1967).

A sine-modulated beam of monoenergetic neutrons was produced by reflecting a collimated thermal beam from a quartz piezoelectric crystal. The modulation frequency was 1 Mc/s, twice the value of the piezoelectric resonance frequency. With the maximum driving voltage on the crystal, a peak to background ratio of approximately 10 was obtained. (auth)

36458 DETECTION OF A SOURCE AGAINST A BACKGROUND USING MULTICHANNEL PULSE HEIGHT DATA. Stinchcomb, T. G. (Illinois Inst. of Tech., Chicago). Nucl. Instrum. Methods, 53: 305-8(1967).

A new rule is suggested by which multichannel data can be used to determine whether a line source is present above a continuous background with less probability of an error than by the rule commonly applied to single-channel data. An example demonstrates the application of the new rule and compares the results from it with the results (using the same data) from the single-channel rule. The suggested new rule and the example show the need for the presentation of a rigorous theory by which multichannel data can be applied to the making of decisions concerning the presence of a source above a background. (auth)

36459 GENERATION OF CONSTANT AMPLITUDE NEEDLE PULSES AND PROBLEM OF PULSE AMPLITUDE MEASUREMENT BY THE PRINCIPLE OF NUCLEAR PHYSICS ASSEMBLY. Brust, R.; Schoenfeld, E. (Deutsche Amt fuer Messwesen und Warenpruefung, Bereich Metrologie, Berlin). Nucl. Instrum. Methods, 53: 309-12(1967). (In German).

A needle pulse generator generating pulses with highly constant amplitudes between 10 and 100 V is described. The methods for measuring pulse heights are listed and briefly discussed. The construction of the pulse height measuring device is explained, which operates on the principle of a diode discriminator and allows to measure the heights of the generator pulses with an accuracy of ±0.05 V ± 0.2%. (auth)

36460 TIME ENCODER WITH 2048 CHANNELS OF 100 PSEC AND HIGH STABILITY. Thenard, J.; Victor, G. (Atomic Energy Establishment, Saclay, France). Nucl. Instrum. Methods, 53: 285-9(1967). (In French).

The design and realization of a time encoder having 2048 channels of 100 psec width with a stability better than 10^{-4}/°C and a channel boundary of 10 psec are discussed. The time interval θ to be measured is converted into an interval $K\theta = T$ ($K = 100$). A 100 MHz oscillator, triggered during the time interval T, drives a scaler. The binary states of the scaler can be fed into a ferrite core memory or a computer. (auth)

36461 AUTOMATIC DEAD-TIME CORRECTION FOR MULTICHANNEL PULSE-HEIGHT ANALYZERS AT VARIABLE COUNTING RATES. Harms, J. (Oesterreichische Hochschule, Vienna). Nucl. Instrum. Methods, 53: 192-6(1967).

A new system for automatic correction of dead-time losses of multichannel analyzers is described. Correction is performed by storing compensating pulses distributed over all channels with the same distribution as the measured pulse-height distribution. The integral number of compensating pulses to be stored is derived from comparing the integral number of pulses really stored in the analyzer with the number of detector pulses to be stored. Dead-time losses are corrected accurately not only for constant counting rates, but also if the counting rate is varying during the measurements as long as the pulse-height distribution remains constant. If both, counting rate and pulse-height distribution are varying, dead-time correction is not accurate for very short-lived radionuclides. The limit of this system is only reached at half lives, some orders of magnitude shorter than with conventional dead-time correction. (auth)

36462 CORRECTION OF IMAGE ABERRATIONS OF SECOND ORDER FOR MASS OR ENERGY SEPARATORS CONSISTING OF ONE SINGLE MAGNETIC SECTOR FIELD. Wollnik, H. (Justus Liebig-Univ., Giessen, Ger.). Nucl. Instrum. Methods, 53: 197-215(1967).

Image aberrations of second order are presented for mass separators consisting of one homogeneous or inhomogeneous magnetic sector field, whereby the influence of the fringing fields are included in these expressions. Using a graphical method similar to linear programming techniques the derived aberrations can be corrected by proper choice of the curvatures of the entrance and exit boundaries of the magnet. As an example finally such a correction is carried out for a stigmatic focusing symmetric mass separator using a magnetic field with the inhomogeneity factor $n = 0.5$ and with perpendicular entry and exit of the ion beam into and out of the sector field. (auth)

36463 ON-LINE MASS SPECTROMETER FOR THE STUDY OF VERY SHORT-PERIOD ISOTOPES PRODUCED BY NUCLEAR REACTIONS. Klapisch, R.; Chaumont, J.; Philippe, C.; Amarel, I.; Fergeau, R.; Salome, M.; Bernas, R. (Institut de Physique Nucleaire, Orsay, France. CNRS, Orsay, France). Nucl. Instrum. Methods, 53: 216-28(1967). (In French).

A mass spectrometer is described which, used on-line with the

extracted beam of an accelerator, allows the measurement of isotopic ratios of even the very short-lived nuclides ($T \ll 1$ sec) produced in nuclear reactions. One can thus measure independent formation cross sections of nuclides far from stability and also identify new isotopes. A target, heated to a temperature of about 1500°C is bombarded by a high energy proton beam. The target is made of a stack of metal and graphite slabs so that the energetic recoils, originating in the target, are stopped in the graphite catchers from where they will diffuse out easily. By surface ionization, alkali atoms are then specifically ionized and the ions accelerated and analyzed by a conventional magnetic sector Nier type mass spectrometer. Detection at the collector is achieved by a secondary electron multiplier delivering a voltage pulse for each ion impinging on its first dynode. The apparatus is described (reaction chamber, vacuum system, ion detection and counting equipment etc...) it is a mobile type of installation and can be set in few hours in the beam of an accelerator. The confection of the target is the most delicate part of the technique, and examples are given of applications to various problems of spallation, fission and fragmentation reactions. The sensitivity of the method to very small cross sections and also to very short half lives is discussed. The efficiency has been estimated in a few instances and cross sections of the order of 10 μb can be measured accurately. Radioactive decay during diffusion will limit the half lives of the nuclides that can possibly be studied. Diffusion phenomena in the target have been analyzed and a procedure is described to correct cross sections for this decay. Measurements have been made on several nuclides with half-lives of the order of 0.2 sec but nuclides of much shorter half-lives (a few tens of msec) could be detected. Applications of the method are discussed in the last section and include measurement of cross sections, identification of isotopes far from stability produced in complex nuclear reactions and also production of separated beams of short lived isotopes for nuclear spectrometric studies. (auth)

36464 DOUBLE-FOCUSSING BETA SPECTROMETER WITH HIGH DISPERSION AND INTERMEDIATE IMAGE FOR MEASUREMENT OF CONVERSION ELECTRONS FOLLOWING NEUTRON CAPTURE. Mahlein, H. F. (Technische Hochschule, Munich). Nucl. Instrum. Methods, 53: 229-48(1967). (In German).

Calculations were done for several double focusing flat-type magnetic spectrometers for measuring conversion electrons following neutron capture. The target is located at the reactor core and the spectrometers combine homogeneous and 1/r magnetic fields. A very advantageous arrangement with a high dispersion and an intermediate image is proposed in which a spectrometer consisting of two sector fields (1/r, homogeneous) and a spectrometer consisting of three sector fields with mirror symmetry (homogeneous, 1/r, homogeneous) are combined. With a distance of 5.50 m from the target to the first spectrometer and a solid angle of 3×10^{-4} sr, the base resolution for a target width of 1 cm equals 1.5×10^{-3}. This means that for a target width of 1 cm both the resolution and the solid angle are improved by a factor of two as compared to the old spectrometer installed at the Munich research reactor. (auth)

36465 A PRECISION, COMPUTER-CONTROLLED PULSE GENERATOR AND ITS APPLICATION. Black, W. W. (National Reactor Testing Station, Idaho Falls, Idaho). Nucl. Instrum. Methods, 53: 249-56(1967).

A precision pulser was designed and interfaced to a small digital computer. It is entirely under program control and has a linearity and stability of a few parts in 10^5. Complete descriptions are given of programs which allow the user to measure essential parameters of amplifier plus analog-to-digital converter systems, including deviations from linearity, channel profiles, zero level stability, and gain stability. In addition it is shown how the pulser can be used for digital stabilization and for gain equalization in multiparameter experiments. Particular emphasis is given to the ways this instrument can be utilized for making precision energy measurements using lithium-drifted germanium detectors. (auth)

36466 WIDE RANGE MICROCIRCUIT PULSE GENERATOR. Pitke, M. V. (Tata Inst. of Fundamental Research, Bombay). Nucl. Instrum. Methods, 53: 257-60(1967).

A wide range pulse generator using only three flat-packs was described. This can deliver pulses with rise/fall times in the range of 10–15 ns, width variable from 30 ns to 7 ms and repetition rates variable from a few hundred hertz to well over 10 MHz. (auth)

36467 BALLISTIC PENDULUM (Engineering Materials). (Sandia Corp., Albuquerque, N. Mex.). (CAPE-1616).

22 drawings.

A ballistic pendulum is described which is used for the calibration of transducers employed in the measurement of acceleration produced by shock pulses. In the pendulum, alignment and adjustment stability are good. Metal support cables provide stability. In operation, an acceleration force is applied to a transducer by the impact of a ¾ lb bullet. The transducer is held in position as a stationary body. (For details see TID-4100 Suppl. 41) (F.S.)

36468 DIFFERENTIAL OR INTEGRAL DISCRIMINATOR (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1599).

3 drawings.

Coincidence-anticoincidence and discriminator circuits are described. The discriminator circuit consists of an upper and lower discriminator with anticoincidence output pulses. The discriminator circuit determines the energy of interest and generates pulses which are used by the coincidence circuit for determining the time coincidence of events in their energy intervals. These drawings are modifications of drawings included in CAPE-887. (For details see TID-4100 Suppl. 41). (F.S.)

36469 SOLID-STATE PLUG-IN CIRCUITS (Engineering Materials). (Savannah River Operations Office (AEC), Aiken, S. C.). (CAPE-1631).

7 drawings.

Seven standard solid-state circuits are described. The circuits are used in radiation instruments and include a pulse amplifier, variable discriminator, pulse-shaping univibrator, counting tube (dekatron) driver, count rate meter, and multiple range and time constant circuits to operate with the count rate meter. The circuits may be combined to make instruments for specific needs. (For details see TID-4100 Suppl. 41). (F.S.)

36470 DUAL REGULATED POWER SUPPLY /Q-2805/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1607).

1 drawing.

A general purpose line-regulated power supply is described which is used to provide 24 V dc at 2A to the radiation alarm system. The power supply consists of a transformer, rectifiers, condensers, and a filter. The chassis is satin finish cold-rolled Cd plated 18 gauge steel and the panel is fabricated of Al. (For details see TID-4100 Suppl. 41). (F.S.)

36471 LIQUID CHROMATOGRAPHY MONITORING SYSTEM (Engineering Materials). (Oak Ridge Gaseous Diffusion Plant, Tenn.). (CAPE-1626).

3 drawings.

The sampler, chain, electrometer, and autoranging recorder for a liquid chromatography monitoring system are described. The system is used in analyzing a flowing stream for dissolved organic constituents, specifically to monitor effluent from liquid-liquid or liquid-solid chromatography columns. (For details see TID-4160 Suppl. 41). (F.S.)

36472 ALPHA EXPERIMENT /Q-2892/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1465).

5 drawings.

Circuits for the control unit, amplifier and discriminator, and fast and slow gatings are described. The electronic equipment is used in an accelerator experiment. Other electronic equipment employed in the experiment includes shapers, 400-channel analyzers, amplifiers, scalers, and beam current integrators. A block diagram for the experiment is included. (For details see TID-4100 Suppl. 41). (F.S.)

36473 ECHO SELECTOR /Q-2896/ (Engineering Drawings). (Oak Ridge National Lab., Tenn.). (CAPE-1469).

1 drawing.

An echo selector is described which selects any two of a series of ultrasonic reflections created by a pulse induced into a metal sample by a transducer and records two dc voltage levels proportional to the amplitude of the selected pulses. All circuitry uses solid state components. FET transistors are used in the multivibrators and in the pulse stretcher. (For details see TID-4100 Suppl 40) (F.S.)

36474 FORTY-CHANNEL PORTABLE FM SYSTEM (Engineering Materials). (Sandia Corp., Albuquerque, N. Mex.). (CAPE-1618).

23 drawings.

A 40-channel frequency modulation system is described which consists of a portable unit consisting of voltage-controlled oscillators, signal conditioners, amplifiers, and test equipment. The system provides an efficient means for acquiring transducer data at locations not easily serviced by existing data centers. The system is contained in a cabinet 29 by 51 by 73 in. in size. The system is capable of recording 20 channels of either strain gage, bridge-type, or swept resistance-type transducer data, or combinations of these types and 20 channels of either voltage monitors, current monitors, or accelerometer data from charge

amplifiers, or combinations of these types. (For details see TID-4100 Suppl. 41) (F.S.)

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 36405.

36475 (NP-16772) GEFAEHRDUNG ELEKTRONISCHER SYSTEME DURCH RADIOAKTIVE STRAHLUNG (STRAHLENSCHAEDEN IN TRANSISTOREN). (Damaging Electronic Systems by Radioactive Radiation (Radiation Damages in Transistors). ABC Bulletin No. 10. Steinemann, A. (European Organization for Nuclear Research, Geneva (Switzerland)). [1966]. 36p. (In German). Dep.

Sensitive electronic systems can be damaged by intense γ, β, and neutron radiations. They are then taken out of service with immediate or delayed effect (latency time). Such phenomena were observed in the vicinity of nuclear reactors. The tolerance doses for transistors is approximately at fluxes of 10^{16} neutrons/cm^2, 10^{15} electrons/cm^2, or 10^{15} γ quanta/cm^2. The human doses that can be compared to these tolerance values approaches 10^9 rem (n) or 10^7 (γ) if they are calculated for the fission energies of N and γ. The irradiations tolerated for transistors are several orders of magnitude above the lethal dose for humans. In the military domain, the survivors of a nuclear explosion will always find intact electronic devices. The damaging of the electronic devices by the radiation from radioactive fall-out is improbable, since normalized values of γ radiation of l_1 (γ) $\geq 10^5$ r/hr are necessary. The dangers of damages caused to military electronic apparatus during a war is almost zero and can not be considered as an obstacle to the use of transistors on a large scale. The physical effects produced by radioactive radiation in the transistors can be compared to the effects produced in living tissues. If the enormous differences in the order of magnitude are neglected, the qualitative comparison of the effects (solid state—living tissue) shows great analogies. (tr-auth)

36476 (SC-R-67-1158) ANALYSIS OF RADIATION EFFECTS IN SEMICONDUCTOR JUNCTION DEVICES. Gwyn, C. W.; Scharfetter, D. L.; Wirth, J. L. (Sandia Corp., Albuquerque, N. Mex.). July 1967. Contract AT(29-1)-789. 59p. (CONF-670708-3). Dep. CFSTI.

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio.

A computer program was written for the prediction of transient and permanent radiation damage in junction devices. This program calculates the transient solutions of Poisson's Equation and the continuity equations throughout a one-dimensional structure. Mobility, lifetime and carrier generation are described by nonlinear functions of carrier density and current so that scatter limiting velocity, Shockley-Read-Hall recombination and avalanche ionization phenomena are described. Three examples are presented which illustrate the utility of such programs in predicting both ionization and displacement damage effects in a PIN diode and a bipolar transistor. (auth)

36477 THE PRODUCTION AND USE OF UNSCANNED WIDE-AREA ELECTRON BEAMS FOR SPACE RADIATION-EFFECTS STUDIES. Kuehne, F. J.; Favale, A. J. (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). Trans. Amer. Nucl. Soc., 10: 40(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 35858, 35859, 36618, 36631, 36647, 36648, and 36711.

36478 (AD-637574) EFFECTS OF X-IRRADIATION ON THE HEXOBARBITAL METABOLIZING ENZYME SYSTEM OF RAT LIVER MICROSOMES. Report for December 1, 1965–May 31, 1966. Yam, Kei-ming; DuBois, K. P. (Chicago Univ., Ill. Toxicity Lab.). June 1966. Contract AF 41(609)-2977. 33p. CFSTI.

The influence of X-ray on the development of a hepatic microsomal oxidase that catalyzes the oxidative detoxification of hexobarbital was studied. Exposure of 23-day old male rats to 400 R of x-ray completely inhibited the rapid increase in enzyme activity that normally occurs at this age in male rats. After three weeks following radiation exposure, reversal of the inhibition was observed. Exposure of only the heads of male rats also resulted in inhibition of the enzyme development in the liver, and hypophysectomized, unirradiated rats failed to exhibit the normal increase in enzyme activity. The findings resembled the results of previous investigations in this laboratory on other microsomal enzymes and provided further evidence that radiation acts on some process involved in the synthesis of increased enzyme activity in the livers of male rats through an indirect mechanism probably involving hormonal regulation of microsome enzyme synthesis. X-irradiation (400 R) also inhibited the synthesis of the hexobarbital oxidizing enzyme in the liver of partially hepatectomized male rats. A prolonged duration of action of hexobarbital in irradiated young male rats and hepatectomized, adult rats demonstrated the in vivo effects of inhibition of enzyme synthesis on drug metabolism. (CFSTI)

36479 (NYO-3497-11) PRIMARY PRODUCTIVITY IN THE CHESAPEAKE BAY DURING THE SUMMER OF 1964. Technical Report No. 34, Reference 67-1. Taylor, W. Rowland; Hughes, John E. (Johns Hopkins Univ., Baltimore, Md. Chesapeake Bay Inst.). Apr. 1967. Contracts Nonr-4010(12); AT(30-1)-3497. 35p. Dep. CFSTI.

Primary production by the phytoplankton of the upper Chesapeake Bay averaged about 1.5 to 3.5 gC m^{-2} day^{-1} during the summer of 1964. Production in the tributaries was generally less than the open bay. This level of primary productivity is about the same as has been noted for other estuaries during summer months. On an annual basis, the production would be higher since the spring bloom phenomenon was not included in these measurements. The technique was evaluated by a series of rate measurements and a precision estimate. The precision of the method was estimated at about 20%. An endogenous physiological diurnal rhythm was noted but variations in photosynthetic capacity during the time of day that measurements were made was only about 25%. The ecological significance of these observations is discussed. (auth)

36480 (ORO-1643-083) STUDIES IN IODINE METABOLISM. Eighteen Year Progress Summary, 1948–1967. Van Middlesworth, L. (Tennessee Univ., Memphis. Dept. of Physiology and Biophysics). July 31, 1967. Contract AT(40-1)-1643. 18p. Dep. CFSTI.

Results are summarized from an 18-year study of factors that regulate iodine metabolism in the thyroid of man and experimental animals. A study of the enzymatic iodination of casein led to the discovery in 1954 that fresh thyroid glands from cattle contained ^{131}I. Since that time over 60,000 thyroid glands from various sources throughout the world have been analyzed and the data stored on IBM computer tape. Therefore, the content of ^{131}I in fallout can be followed from 1957 through 1963. A small number of the cattle thyroids monitored for ^{131}I contained long-lived radioactivity due to Ra. (159 references.) (C.H.)

36481 (NASA-TT-F-465) EFFECT OF ELECTROMAGNETIC AND MAGNETIC FIELDS ON THE CENTRAL NERVOUS SYSTEM. Kholodov, Yu. A. Translation of Vliyaniye Elektromagnitnykh i Magnitnykh Poley na Tsentral'nuyu Nervnuyu Sistemu, Izdatel'stvo Nauka, Moscow, 1966. 250p. CFSTI.

The physiological mechanism of the effect of electromagnetic fields (EMF) on the functions of the brain was studied using electrophysiological and conditioned-reflex methods. Various methods of recording motor activity and determining the sensitivity to electrical and chemical stimuli, and morphological methods used are described. The experimental animals were different classes of vertebrates, beginning with fish and ending with mammals. (auth)

36482 ELECTRON-MICROSCOPIC INVESTIGATIONS ON THE RADIATION EFFECTS ON LIVER CELLS OF MOUSE FETUS. Pipan, Nada (Univ., Ljubljana, Yugoslavia). Strahlentherapie, 133: 268-79(June 1967). (In German).

Liver tissue of 13, 15, and 17 day old normal mice embryos as well as embryos of the same age that were irradiated intrauterine with 1200, 1500, 1700, and 1800 R 1, 2, or 3 days prior to removal was investigated. There is little difference in the histological structure of the liver cells of 13, 15, and 17 day old embryos; only the amount of glycogen is very high in 17 day old cells. The irradiated embryonal liver of all the age groups investigated showed damaged cells as well as cells with little or no signs of radiation influence. Most of the damages were found in 13 and 15 day old embryonal liver cells that were irradiated 2 or 3 days prior to removal. Invaginated and swollen mitochondria which apparently are only partly destroyed by bursting, as well as nuclei with fatty vacuoles could neither be found in irradiated liver nor in other organs irradiated. (auth)

36483 ION BINDING BY SERUM PROTEIN. Cho, Chai Moo; Greco, Joseph; Kaplan, Ervin (Veterans Administration, Hines, Ill.). Trans. Amer. Nucl. Soc., 10: 80(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36484 EFFECT OF A CHOLINE-DEFICIENT DIET UPON ZINC, MANGANESE, AND MAGNESIUM LEVELS IN THE RAT HEART AND LIVER. Barak, Anthony J.; Beckenhauer, Harriet C. (Veterans Administration Hospital, Omaha, Neb.). Trans. Amer. Nucl. Soc., 10: 58-60(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36485 EFFECT OF WHOLE-BODY GAMMA-IRRADIATION ON THE SUBCELLULAR DISTRIBUTION OF PROTEINASES IN RAT THYMUS. Furlan, Miha; Jericijo, Marija (Jozef Stefan Nuclear Inst., Ljubljana, Yugoslavia). Strahlentherapie, 133: 262-7(June 1967).

Specific activities of proteolytic enzymes were measured in the nuclear, particulate, and supernatant fraction of rat thymus within 6 hours after 600 R whole-body γ irradiation. Effect of in vitro irradiation on the intracellular proteinase distribution was investigated in thymocyte suspensions exposed to a dose of 23,000 R. No important radiation-induced release of proteinases was observed under the described experimental conditions. NAD was shown to inhibit the hydrolysis of histone and hemoglobin by the nuclear proteolytic enzymes, while nicotinamide had no effect. (auth)

36486 UPTAKE OF ^{90}Sr BY THE CHLORELLA VULGARIS. II. UPTAKE OF ^{90}Sr FROM RADIOISOTOPIC CONCENTRATION IN THE SOIL. Avio, Carlo Maria; Rossi-Torelli, Miranda (Centro Applicazioni Militari Energia Nucleare, Pisa, Italy). Pubbl. Sta. Zool. Napoli, 34: 346-54(1965). (In Italian).

The ionization potential (IP) of uranium was measured using the high-temperature slope of the Saha-Langmuir plots and 4.58 eV for the work function of polycrystalline tungsten. The average of 25 separate determinations (each determination consisting of 10 temperature runs) gave an IP for uranium of 6.24 eV but with a standard deviation of 0.34 eV. The comparison technique was then employed using UF_4, PbF_2, $PbCl_2$, and AgBr. Silver was included to further check the validity of the method by permitting comparison of the IP of silver and lead. The three ion intensities were plotted. For silver and lead there was no deviation from a straight line over the entire temperature range studied. Uranium yielded a straight line only over the high-temperature portion. The effect of some oxygen contamination was apparent at lower temperatures. The difference in IP of lead and silver was 0.13 ± 0.02 eV in good agreement with the value of 0.159 eV obtained from the accepted values of these ionization potentials. The IP of uranium was determined to be 6.22 ± 0.06 eV. It is apparent from these results that many simple compounds must dissociate completely on striking a hot metal surface, but that certain elements (uranium, for one) are very sensitive to contaminants on the surface. (D.H.M.)

36487 UPTAKE OF ^{90}Sr BY THE CHLORELLA VULGARIS. I. UPTAKE OF ^{90}Sr DURING THE GROWTH OF CHLORELLA VULGARIS. Avio, Carlo Maria; Rossi-Torelli, Miranda; Lenzerini, Luciano (Centro Applicazioni Militari Energia Nucleare, Pisa, Italy). Pubbl. Sta. Zool. Napoli, 33: 264-73 (1963). (In Italian).

Strontium-90 and ^{90}Y uptake during the growth of Chlorella vulgaris population in an artificial medium was investigated. Growth of the population was not affected by the presence of 15×10^{-3} μc/ml of radioisotope. Two hours after the inoculum, algae show 0.0712% of ^{90}Sr and 30.96% of ^{90}Y present in the medium. At the end of log phase of the growth, radioactivity in the algae was due to an average of 5% of ^{90}Sr and 91% of ^{90}Y of the whole radioactivity present in the medium. These percentages correspond to $33 \cdot 10^9$ atoms of ^{90}Sr and $0.16 \cdot 10^9$ atoms of ^{90}Y. Algae take up an amount of ^{90}Sr 200 times greater than ^{90}Y. Reduction of radioactivity in the medium was very large at the moment of the separation of the algae, but actually it was only the 5% which was due to the uptake of ^{90}Sr by the algae. Average rate of uptake by a single cell was 34×10^{-9} from the seventh day on. Concentration factor related to 1 g of algae was 1500. (auth)

36488 PROTEIN SYNTHESIS AND ENZYMIC PATTERNS IN THE DEVELOPING BRAIN FOLLOWING HEAD X-IRRADIATION OF NEWBORN RATS. de Vellis, J.; Schjeide, O. A.; Clemente, C. D. (Univ. of California, Los Angeles). Contract AT(04-1)-GEN-12. J. Neurochem., 14: 499-511(1967). (UCLA-12-601).

Various parameters were measured during postnatal brain development in normal rats and in rats which received 750 R of x radiation to the head at 2 days after birth. The protein content of the irradiated brain stem was found to be lower than normal after 8 days of age while the lipid and proteolipid-protein contents showed a departure from normal after 12 days. There was no evidence of recovery during the period of observation (up to 57 days). The rate of incorporation of ^{14}C leucine into protein and proteolipid-protein of brain stem slices was linear with time and decreased with the age of the animal. Irradiation depressed the rate of chloroform–methanol insoluble protein at 6 days of age and thereafter. The specific activities of glycerolphosphate dehydrogenase, malate dehydrogenase (1.1.1.40) malate dehydrogenase (1.1.1.37) and lactate dehydrogenase increased during development (7, 3, 2.5 and 2 times, respectively) in the cerebral hemispheres and the brain stem. Isocitrate dehydrogenase, however, decreased threefold in the brain stem and sixfold in the cerebral hemispheres. A difference in the tissue distribution of each enzyme was found for malate dehydrogenase (1.1.1.37). Irradiation inhibited differentially the development of all enzymes in terms of total activity per tissue. The specific activities of glycerolphosphate dehydrogenase and isocitrate dehydrogenase were reduced. These enzyme deficiencies might be responsible for the inhibition of myelination by blocking the synthesis of phospholipids. (auth)

36489 EFFECTS OF VARIOUS AGENTS ON PRIMING ACTIVITY OF DNA FOR ESCHERICHIA COLI DNA POLYMERASE. Harrington, Helen (Western Reserve Univ., Cleveland). J. Mol. Biol., 15: 152-9(Jan. 1966). (COO-78-132).

When a dilute solution of DNA was subjected to a 1000 R dose of x rays, its priming activity for Escherichia coli DNA polymerase was decreased when assayed at high concentrations of DNA. However, it was increased when low concentrations of DNA were used in the polymerase assay system. When other agents known to produce single- and double-strand breaks (DNAase I, DNAase II, and ultrasound) were used to treat DNA to give the same decrease in the specific viscosity as that produced by 1000 R x radiation, its priming activity was increased irrespective of the concentration of DNA used in the polymerase assay. Treatment of the primer with uv radiation decreased priming activity at all concentrations of DNA used in the polymerase assay. Heat denaturation produced an effect upon priming activity similar to that of x irradiation: a decrease in activity was observed only when high concentrations of DNA were used in the polymerase assay. It is possible, therefore, that single-stranded regions present in irradiated DNA account for the observed changes in priming activity. However, the possibility that x irradiation produces more than one type of structural alteration in DNA cannot be excluded. (BBB)

36490 COMBINED ACTION OF DEUTERIUM OXIDE AND CHEMOTHERAPY ON TRANSPLANTABLE MOUSE TUMORS. Finkel, Asher J.; Czajka, Dorice M.; Katz, Joseph J. (Argonne National Lab., Ill.). Cancer Chemother. Rep., 50: 641-7(Dec. 1966).

The combined effects of deuterium oxide (D_2O) and antitumor agents on Krebs-2 ascites tumor in mice were examined. Colchicine, 5-fluorouracil, 6-mercaptopurine, and cyclophosphamide appeared to be more effective, though more toxic, in animals treated with D_2O; suppression of tumor growth was accompanied by shortened survival time. Additive effects were observed with D_2O and 5-fluorouracil, while a distinct potentiation resulted from a combination of colchicine or cyclophosphamide with D_2O. The action of aminopterin and cyclophosphamide was also enhanced against the mouse ascitic leukemia L4946 by D_2O. (auth)

36491 X-RAY SURVIVAL AND DNA SYNTHESIS IN CHINESE HAMSTER CELLS. I. THE EFFECT OF INHIBITORS ADDED BEFORE X IRRADIATION. Sinclair, Warren K. (Argonne National Lab., Ill.). Proc. Nat. Acad. Sci. U. S., 58: 115-22 (July 1967).

The x-ray survival response of synchronous Chinese hamster cells in vitro was modified by inhibiting DNA synthesis with hydroxyurea and excess thymidine, protein synthesis with cycloheximide, and RNA synthesis with actinomycin D. Combinations of these agents were also used. When only DNA synthesis was postponed by inhibiting cells in G_1 (the pre-DNA synthetic period), cells initially became more sensitive to x radiation (710 rads) and then became resistant again. Compared with irradiated control cells, this resistance in inhibited cells was delayed in time, and survival was markedly less. It was not altered when protein synthesis and/or RNA synthesis were also arrested while the cells were in their most sensitive state. When protein synthesis was postponed along with DNA synthesis from the beginning of the cycle, cells did not become more sensitive but neither did they reach the full survival maximum of irradiated control cells in late S. A similar result was found when RNA synthesis was inhibited with actinomycin D. Maximum survival was therefore dependent in part on DNA synthesis but was also dependent on other processes in the cell. X-ray survival remained at its maximum value when, at this cycle stage, cells were inhibited from continuing DNA or protein synthesis by excess thymidine or cycloheximide. Survival thus depended upon the stage the cell had reached in the cycle (of which DNA synthesis is part) and not on whether active DNA or protein synthesis was in progress just prior to irradiation. (auth)

36492 ULTRAVIOLET LIGHT AND GLYCOGEN FORMATION IN THE HUMAN EPIDERMIS. Ohkawara, Akira; Halprin, Kenneth M. (Univ. of Oregon, Portland). Arch. Dermatol., 95: 416-21(Apr. 1967).

Effects of uv irradiation of the skin on glycogen in the epidermis were studied in humans exposed to 2, 4, or 6 minimal erythema doses from a hot quartz lamp. Biopsied skin samples revealed histochemically demonstrable glycogen in the epidermis when the level of glycogen was above 400 to 500 mμg/mg of fresh tissue. It was found normally in the malpighian cells of the epidermis. Seven to 12 hr after uv irradiation glycogen accumulated in the malpighian cells reached a peak at 24 hr, and persisted for at least 18 days. Increases in malpighian cell glycogen were also found in nonexposed areas after uv irradiation. Basal cell glycogen was not found in normal epidermis nor did it appear in nonexposed areas after uv irradiation. In exposed areas it appeared 4½ hr after irradiation, reached a peak at 7½ to 12 hr, and disappeared by 24 to 44 hr. Changes in the activities of the enzymes glycogen synthetase and phosphorylase did not correlate with the changes in epidermal glycogen content. (BBB)

36493 EFFECT OF 2000- AND 5000-R GAMMA-RAY IRRADIATION ON THE FIBRINOLYSIN ACTIVITY OF STREPTOKINASE-STREPTODORNASE. Szirmai, E. (Technische Hochschule, Stuttgart); Stamm, H. Haematol. Lat. (Milan), 9: 271-7(1966).

The in vitro effect of irradiation on a fibrinolysin preparation was studied by irradiating Varidase (streptokinase–streptodornase) with 2000- and 5000-R doses of ^{60}Co γ rays. Two different batches of Varidase were used, each vial containing 20,000 units of streptokinase and 5000 units of streptodornase. The following tests were used to study the effect of Varidase on blood clotting and fibrinolysis before and after irradiation: clotting time of recalcified plasma, thrombin clotting time, fibrinolytic activity on nonheated fibrin plates, autocoagulography and thrombelastography. Irradiation with 2000 and 5000 R did not substantially affect the activity of the fibrinolysin. The anticoagulant activity of the preparation was retained in all the clotting systems used. (BBB)

36494 THE RELATIONSHIP BETWEEN THE RATE OF DNA SYNTHESIS AND ITS INHIBITION BY ULTRAVIOLET LIGHT IN MAMMALIAN CELLS. Cleaver, J. E. (Massachusetts General Hospital, Boston). Radiat. Res., 30: 795-810(Apr. 1967).

The rate of tritiated thymidine (^3HTdr) incorporation into DNA varied with temperature according to a linear Arrhenius relation between 4° and 40°C, with an activation energy of 25.8 kcal/mole. After irradiation with moderate doses only a small fraction of the genome completed replication, and DNA synthesis stopped within 2 hours. Dose-response curves for the inhibition of DNA synthesis at temperatures of 25°, 31°, and 37°C were all of the biphasic or multiphasic type, and the sensitivity to irradiation was higher when the rate of DNA synthesis was higher. The temperature during irradiation was irrelevant, and only the temperature after irradiation had any effect on the observed inhibition. The observations were interpreted in terms of a model in which blocks to replication are introduced into DNA by irradiation and replication ceases when the first block is reached. Simple calculations indicate that

pyrimidine dimers may not be effective blocks in mammalian cells. The photoproducts that block replication are formed by UV with about 10% of the efficiency of dimer formation. An increase in the fraction of cells incorporating ^{3}HTdr after irradiation was observed in the human cell strain, but not the mouse strain; this may be due either to DNA repair or to abnormal DNA synthesis. (auth)

36495 TRIGLYCERIDE SYNTHESIS FOLLOWING WHOLE-BODY X-IRRADIATION IN THE RABBIT. Wooles, W. R. (Medical Coll. of Virginia, Richmond). Radiat. Res., 30: 788-94(Apr. 1967).

The effect of whole-body x radiation (1000 R) on triglyceride metabolism prior to and during the development of postirradiation hyperlipemia in the rabbit was studied. The conversion of palmitic acid-1-^{14}C into liver triglyceride was increased at 2, 4, and 16 hr after exposure. However, the concentration of plasma triglyceride in irradiated rabbits was not altered until 16 and 24 hr after radiation exposure, when increases of 878% and 366%, respectively, were observed. The specific activity of liver triglyceride was increased at 2 and 4 hr postirradiation. However, the specific activity of plasma triglyceride of irradiated rabbits was similar to that of the control group at each postirradiation time period, since the incorporation of the label and the concentration of plasma triglyceride increased proportionally at the 16-hr and 24-hr postirradiation time periods. (auth)

36496 THEORY OF RBE FOR HEAVY ION BOMBARDMENT OF DRY ENZYMES AND VIRUSES. Butts, J. J.; Katz, Robert (Kansas State Univ., Manhattan). Radiat. Res., 30: 855-71(Apr. 1967).

The response of dry enzymes and viruses to heavy ion bombardment may be predicted from their response to γ irradiation (and no further knowledge of their size and structure). The molecules are approximated as point particles whose response to ionization is the same for heavy ion bombardment as for γ rays. From the δ-ray distribution formula and an extrapolated range-energy relation for electrons, the radial distribution of secondary ionization energy may be found. Under this dosage distribution the inactivation probability may be found as a function of radial distance from the ion's path, and then may be integrated over all space to find the inactivation cross section. These essentially geometric theoretical relations between the γ ray D_{37} values and the inactivation cross section constitute a complete theory of RBE for the heavy ion bombardment of these substances. Theoretical relations agree with published experimental values to an average deviation of 15% for the enzymes β-galactosidase and trypsin, and for T-1 and ϕX-174 bacteriophages, when bombarded with ions ranging from Z = 1 to 18, at ion speeds of 0.07 c(2.3 MeV/nucleon) and 0.145 c (10 MeV/nucleon). (auth)

36497 ROLE OF SULFHYDRYL GROUPS IN RADIATION SENSITIVITY AND CHEMICAL PROTECTION IN ENZYMES. Winstead, Jack A. (School of Aerospace Medicine, Brooks Air Force Base, Tex.). Radiat. Res., 30: 832-40(Apr. 1967).

Yeast enolase, rabbit muscle enolase, and beef heart lactic dehydrogenase (LDH) were found to give similar ionic yields when irradiated with γ radiation. The ionic yield for LDH, which has a sulfhydryl in the active site, was slightly less than that for yeast enolase which is void of both sulfhydryl groups and disulfide bonds. Cysteine and 2-mercapto ethylguanidine (MEG) protected all three enzymes against ionizing radiation. On the basis of these results, it is concluded that the presence of sulfhydryl groups in proteins is not a reliable means of predicting radiation sensitivity, and sulfhydryl protective agents can function without the presence of a sulfhydryl or disulfide bond in the protein. It is suggested that the initial event in radiation damage of proteins may be the breakage of H-bonding; then subsequent events may be the destruction of amino acid residues. (auth)

36498 ACTIVITY OF SUCCINODEHYDROGENASE IN MAMMAL TISSUE CELLS IN THE PRESENCE OF A REMOTE MUTAGENIC EFFECT OF IONIZING RADIATION. Yasnova, L. N. (Inst. of Cytology and Genetics, Novosibirsk, USSR). Radiobiologiya, 7: 153-4(1967). (In Russian).

Oxidation of thiol groups on direct irradiation of the organism may produce disturbances in some enzymatic processes and lead to the formation of toxic metabolites. Among these metabolites are thiol inhibitors, the action of which may result in visible chromosome breaks. After mice were exposed to 1500 R of x rays, an extract of their tissues was injected into other mice. Twenty-four hours after introduction of the extract, the brain tissue of the recipient mice showed a decreased activity of succinate dehydrogenase (a thiol enzyme). A reduction of succinate dehydrogenase activity was also observed in mice irradiated directly with a dose of 1500 R, but did not take place in mice into which a tissue extract of non-irradiated mice had been injected. The cells of the cornea of recipient mice into which the tissue extract of irradiated animals had been injected showed an increased mitotic activity when compared with control mice and 3.6% of chromosome aberrations when compared with control mice. (JPRS)

36499 PARAMECIA TOXEMIA REACTION AND THE DETOXIFYING EFFECT OF LOW-MOLECULAR POLYVINYL ALCOHOL IN THE BLOOD OF IRRADIATED RABBITS. Vinogradova, V. G. (Kirov Military Medical Academy, Leningrad). Radiobiologiya, 7: 96-9(1967). (In Russian).

On irradiation of rabbits with x rays at a dose of 1000 R (LD ~ 100), a statistically reliable increase in the toxic reaction of the blood serum of the animals to paramecia developed within the first 24 hr after irradiation. On the 2nd to 4th day after irradiation, the paramecia reaction dropped to its initial level. The toxic reaction dropped to its initial level. The toxic reaction of the serum increased substantially on the 5th to 9th day after irradiation during the period corresponding to the acute stage of radiation sickness. After a 3% solution of polyvinyl alcohol, with a molecular weight of 12,000, (polyvinol) had been injected intravenously into the rabbits in a dose of 10 ml/kg, the toxic reaction of the blood serum to paramecia decreased. The same result was obtained on addition of polyvinol to the blood of irradiated rabbits in vitro. (JPRS)

36500 PYRIMIDINE EXCRETION AFTER IRRADIATION IN RATS. Froeholm, L. O. (National Inst. of Public Health, Oslo. Norwegian Defence Research Establishment, Kjeller). Int. J. Radiat. Biol., 12: 35-49(1967).

Male rats of 200 g body-weight were exposed to whole-body x x irradiation with doses from 50 to 1200 R and urine was collected for the first 24 hours after. Chromatographic separation of desalted urine samples allowed quantitative spectrophotometric determinations of thymidine, deoxyuridine, pseudouridine, and uracil to be made. A marked increase in thymidine excretion is found after irradiation, from 40 to 1800 μg per 24 hours. The thymidine excretion increases with dose in the range investigated. Deoxyuridine gives a similar but smaller and less regular response to irradiation. The excretion of pseudouridine and uracil shows no significant changes with irradiation. The thymine excretion values are so low normally and change so little with irradiation that no acceptable analytical results were obtained for this substance. (auth)

36501 USE OF ^{14}C LABELLED ARGININE TO MEASURE CATABOLIC RATES OF PROTEINS AND THE RECYCLING OF AMINO-ACIDS. Lane, R. S. (Royal Maternity Hospital, Glasgow). Nature (London), 214: 1331(June 24, 1967).

From the studies described it is considered that the decrease in protein catabolic rate and the increased recycling of amino-acids which occur in rats fed a protein-free diet may constitute an adaptive phenomenon for the conservation of protein in the deficient animal. The effects of surgery may, however, be important, with regard to ether anaesthesia and hepatic biopsy, which may affect protein metabolism. The possibility that catabolism and protein synthesis may to some extent be interdependent is important when reviewing experimental work with ^{14}C-arginine. The interpretation of results based on isotope studies of protein metabolism is difficult. A paradoxical situation may arise in that the investigator may seek to divorce synthesis from catabolism and yet at the same time he may be bringing them closer together. (UK)

36502 RADIOMIMETIC ACTION OF PRODUCTS OF THE OXIDATION OF TYROSINE ON THE ERYTHROCYTE MEMBRANE. Lebedeva, N. E.; Gintsburg, E. I.; Trincher, K. S. (Inst. of Biological Physics, Moscow). Radiobiologiya, 7: 148-50(1967). (In Russian).

Products of the enzymatic oxidation of tyrosine apparently contribute to radioinduced injury of cells. The action of these products on erythrocytes was studied. A suspension of erythrocytes was incubated with tyrosine + tyrosinase and investigated by determining its optical density following isotonic alkali hemolysis. A suspension of erythrocytes incubated without the enzyme system served as a control. Tyrosine without tyrosinase did not damage the cells, while damage was produced in the presence of the enzyme. The maximum amount of damage coincided with accumulation of the greatest amount of o-quinones formed by oxidation of tyrosine. Tyrosinase as such exerted a certain damaging effect on the erythrocyte membrane. This damage was not associated with the activity of tyrosinase as an enzyme, because it increased on inactivation of tyrosinase by boiling. It could not have been due to the action of Cu ions, because $CuCl_2$ added in a concentration corresponding to the content of Cu ions in the enzyme did not significantly damage erythrocytes. (JPRS)

36503 CHANGES IN NUCLEIC ACIDS METABOLISM IN THE ONTOGENESIS OF IRRADIATED WHEAT SEEDS. Budnitskaya, E. V.; Stoletov, V. N.; Chopyak, A. M. (Inst. of Biochemistry, Moscow. Lomonosov State Univ., Moscow). Radiobiologiya, 7: 133-7(1967). (In Russian).

Irradiation of dry wheat seeds with γ-rays did not produce any significant changes in the nucleic acid content of the germs. After germination for 24 hr of wheat seeds that had been irradiated with 5 kR, the content of DNA in the germs decreased by 31% (while the RNA/DNA ratio decreased), whereas on germination for 72 hr, the DNA content of the germs increased by 57% (while the RNA/DNA ratio increased). Irradiation of seeds with higher doses (5 to 40 kR) generally reduced the nucleic acid content in the germs after germination or vernalization of the irradiated seeds at 0 to 2°C, except in the case of seeds irradiated with 40 kR and vernalized for 50 days, which showed an increase in the DNA content vs non-irradiated controls at a reduced RNA/DNA ratio. The results obtained do not make it possible to arrive at a definite conclusion as to whether the changes in nucleic acid metabolism were due to a direct effect of radiation or to the action of radiation toxins. (JPRS)

36504 CHANGES IN THE PERMEABILITY OF A NUCLEOPROTEIN MEMBRANE FOLLOWING UV IRRADIATION. Tongur, A. M.; Pasynskii, A. G. (Inst. of Biochemistry, Moscow). Radiobiologiya, 7: 7-12(1967). (In Russian).

A monolayer of calf thymus deoxyribo nucleoprotein that separated a substrate solution of 2M NaCl (containing equivalent amounts of methylene blue and ascorbic acid) from a mixture of peroxidase and H_2O_2 placed on the monolayer was irradiated with UV light. The permeability of the monolayer was determined on the basis of the degree to which a blue color developed in the substrate solution. A dose of UV radiation amounting to 2.0×10^5 erg/cm² (3×10^7 quanta/cm²) increased the permeability of the monolayer by 27%. A study of the kinetics of methylene blue oxidation indicated that diffusion through the non-irradiated monolayer did not correspond to Fick's law, while changes in the monolayer produced by irradiation increased its permeability with the result that the oxidation curve was displaced towards that determined under conditions of free diffusion of the enzyme in the absence of a membrane. (JPRS)

36505 ROLE OF THE SPLEEN IN POST-IRRADIATION DEOXYCYTIDINURIA OF RATS. Tereshchenko, O. Ya. Radiobiologiya, 7: 67-70(1967). (In Russian).

It had been established that on irradiation of rats the urinary elimination of deoxycytidine (DC) increased considerably and that on splenectomy of irradiated rats there was a pronounced decrease in the post-irradiation deoxycytidinuria. A calculation based on experimental determinations showed that the amount of DC excreted was much greater than that which could have formed by decomposition of the DNA of the spleen. The DC excreted on irradiation could be newly synthesized, but not incorporated in DNA because of inhibition of the synthesis of the latter, or derived from increased catabolism of DNA. On introduction to rats of orotic acid (a predecessor of DC) labelled with ^{14}C, the absolute activity of DC eliminated with the urine within 10 hr after irradiation of the rats increased considerably vs that of non-irradiated rats, while the specific activity of DC remained the same as that for control animals. The fact that the specific activity remained unchanged indicated that the ratio of components was not altered as a result of irradiation. One may assume that the spleen aids in the development of post-irradiation disturbances of DC metabolism in other organs and that the activity of the spleen in this respect constitutes one of the pathogenetic mechanisms of radiation injury. The fact that splenectomy relieves the symptoms of radiation sickness is in accordance with this conclusion. (JPRS)

36506 CATABOLISM OF SERUM PROTEINS AFTER X-IRRADIATION. Reuter, A. M.; Gerber, G. B.; Kennes, F.; Remy-Defraigne, J. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Radiat. Res., 30: 725-38(Apr. 1967).

Catabolism of a mixture of ^3H-labeled serum proteins was studied in the perfused liver of normal rats and of rats 3 to 5 days after total-body x irradiation (850 R). A significant decrease in radioactivity during the 12-hour perfusion period was observed only for prealbumin and α_2-globulins. Catabolism of serum proteins in the liver appeared to be unchanged after irradiation. Catabolism of a mixture of ^{131}I- and ^3H-phenylalanine-labeled serum proteins was studied in intact normal rats and in rats injected immediately after total-body exposure (800 R). The activity of total protein as well as that of prealbumin, albumin, α_1-, α_2-, and γ-globulins decreased on the fourth day after irradiation below control levels. Thereafter the activity-time curves for most protein fractions of x-irradiated rats paralleled those of the control rats, except that the activity in albumin and γ-globulin decreased in the x-irradiated rats at a much faster rate. It is suggested that serum proteins are lost more rapidly from the circulation, owing to changes in the distribution between the extra- and intravascular space or to a more pronounced extrahepatic catabolism. (auth)

36507 FREE-RADICAL PROCESSES IN γ-IRRADIATED TISSUE HOMOGENATES OF ANIMALS. I. STUDY OF FREE-RADICAL STATES IN HOMOGENATES OF IRRADIATED TISSUES BY POLYMERIZATION METHOD. Kozlov, Yu. P.; Urtile, S.; Tarusov, B. N. (Moscow State Univ.). Nauch. Dokl. Vyssh. Shk. Biol. Nauki, No. 2, 85-9(1966). (In Russian).

Mouse tissue homogenates were exposed to a 100 kR dose of γ radiation after addition of a 5% solution of ^{14}C-labeled acrylamide. The irradiation increased polymerization in homogenates of spleen by 95%, of brain by 69%, of fatty tissues by 50%, and of liver by 19%. Free radicals formed during irradiation of the lipoprotein in cells contributed to the increased polymerization. (W.E.B.)

36508 INFLUENCE OF X-IRRADIATION ON THE PROCESSES OF BIOSYNTHESIS AND DECOMPOSITION OF PHOSPHATE ESTERS OF VITAMIN B_1. Savitskii, I. V.; Leus, N. F. (Odessa State Medical Inst.). Radiobiologiya, 6: 807-11(1966). (In Russian).

The influence of whole-body x irradiation of rats on the content and distribution of thiamine diphosphate was studied, along with the thiamine kinase and thiamine pyrophosphatase activity in the subcellular structures. The experiments were conducted on livers extracted from rats irradiated with R at a dose rate of 26.2 R/min. Such whole-body x irradiation induced a substantial decrease in the level of thiamine diphosphate in the tissue and subcellular structures of the rat liver. The most pronounced changes in the amount of the coenzyme were observed in the mitochondria and supernatant liquid, where the thiamine diphosphate metabolism is most active. The mechanism of the disturbance of the thiamine diphosphate level is apparently associated with changes in the activity of the thiamine kinase and thiamine pyrophosphatase systems. There was substantial inhibition of the thiamine kinase reaction in the mitochondria and a pronounced increase in the thiamine pyrophosphatase activity in the supernatant liquid. (JPRS)

36509 ON THE MECHANISMS OF THE IRRADIATION-INDUCED DEGRADATION OF DNA MACROMOLECULES IN SOLUTION. Ivannik, V. P.; Ryabchenko, N. I. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya, 6: 913-15(1966). (In Russian).

Since the radicals OH· and HO_2·, generated in Fenton's system, are identical in properties with the free radical products of water radiolysis, the effects of radioprotectors upon the degradation of DNA under the action of γ rays and Fenton's reagent were compared. In the presence of excess H_2O_2 chiefly HO_2· radicals are generated in Fenton's reaction, and thus the relative role of HO_2· and OH· radicals in the radiation destruction of DNA macromolecules in solution can be determined from such a comparison. It was found that under treatment of DNA with Fenton's reagent, the concentration of active products leading to DNA degradation increases as a linear function of the H_2O_2 and Fe^{++} concentrations in solution. In the absence of Fe^{++}, the degrading action of H_2O_2 was reduced by an order of magnitude; the addition of the complexing agent EDTA to the medium (10^{-3} M) provided 95% protection of DNA from degradation. The protective properties of a series of sulfur-containing compounds (thiourea, cysteine, AET, and cystamine) and propyl gallate, which is an inhibitor of free radical reactions, were determined for both γ irradiation and treatment with Fenton's reagent. For most of the substances, the protective effect in Fenton's system, was either reduced (thiourea) in comparison with the protective effect in γ irradiation or was absent altogether (propyl gallate, AET, cystamine). Cysteine sensitized the destruction of DNA in Fenton's system (the readily oxidized SH promotes decomposition of H_2O_2). The radioprotectors, relatively ineffective in Fenton's system, do not prevent the interaction of HO_2· with DNA. In view of the effective prevention of DNA degradation in the case of γ irradiation, it is concluded that the basic role in DNA degradation in this case is played by HO· radicals, rather than HO_2·. It is concluded that the primary processes leading to death of the cells are due to radiation damage in DNA, and in particular, to the appearance of single cleavages in the DNA chain. (JPRS)

36510 RADIOSENSITIVITY AND BIOLOGICAL PROPERTIES OF TUMOURS. XI. THE EFFECTS OF X-IRRADIATION ON INTRACELLULAR DISTRIBUTION OF CATALASE. Goldfeder, Anna; Selig, Joseph N.; Miller, Leo A. (New York Univ.). Int. J. Radiat. Biol., 12: 13-25(1967).

Intracellular distribution of catalase activity after x irradiation was determined in two types of mouse mammary epithelial tumors, H and DBrB, in a spindle-cell tumor (DBAG), and in a plasma-cell tumor (Adj-PC-5). Livers and kidneys were used for comparison. Catalase activities were assayed from three sub-cellular fractions: mitochondrial, microsomal, and cell-sap. A decrease in catalase activity in the mitochondrial fraction with a concomitant increase in the cell-sap fraction was noted after x irradiation.

The extent of the release of catalase activity from the mitochondrial to the cell-sap fraction differed between the various tissues. The greatest release after x irradiation was noted in the epithelial tumor (H). This occurrence is obscured in the G and DBrB tumors due to the spontaneous release of this enzyme because of homogenization damage to the boundary membrane in which catalase is encased. It is inferred that the shift in catalase activity from the mitochondrial to the cell-sap fraction is due to the effect of x irradiation on the boundary membrane of the microbody in which the catalase particle is enveloped, releasing this enzyme. The extent of the release of this enzyme seems to be dependent upon the endogenous quality of the membrane surrounding the catalase. (auth)

36511 ENERGY TRANSFER IN NUCLEOPROTEINS. Lenherr, A. D. (Royal Military Coll. of Science, Shrivenham, Eng.); Charlesby, A.; Singh, B. B. Int. J. Radiat. Biol., 12: 51-60(1967).

Artificial nucleoproteins were made by complexing DNA with the proteins BSA, trypsin, and salmine and also with the polypeptide, poly-L-lysine. These nucleoproteins were irradiated with γ rays and examined using electron spin resonance techniques. In all four cases evidence was found that the primary irradiation damage occurred on the DNA moiety of the macromolecules, although this could not be unambiguously shown in the case of the trypsin-DNA complex. (auth)

36512 EFFECTS OF GAMMA RADIATION ON DEOXYRIBONUCLEASE I IN THE PRESENCE OF HIGH CONCENTRATIONS OF SECOND SOLUTES. Okada, S.; Fletcher, G. L. (Univ. of Rochester, N. Y.). Radiat. Res., 30: 667-75(Apr. 1967).

The inactivation of deoxyribonuclease I in aqueous solution by radiation was studied in the presence of high concentration of the second solute (hydroxyethyl cellulose, D-glucose, and glycerol). The initial G value for inactivation of the enzyme was observed to depend on the concentrations of the enzyme and of the second solute, but not on the viscosity of the system. The observed results are in accord with Dale's phenomenon of changing quotient. The inactivation of the enzyme in the high concentration of the second solute was not due to direct action nor to indirect action of classical sense. Possible mechanisms involved have been discussed. (auth)

36513 INTRACELLULAR DISTRIBUTION OF ^{35}S IN THE LIVER AND SPLEEN OF WHITE MICE AFTER INJECTION OF ^{35}S-LABELLED S,β-AMINOETHYLISOTHIOURONIUM, CYSTAMINE, AND 5-THIOPENTYLAMINE DISULFIDE. Vladimirov, V. G. (Military Medical Academy, Leningrad). Radiobiologiya, 7: 71-5(1967). (In Russian).

S,β-Aminoethylisothiouronium (I) hydrobromide, cystamine (II) hydrochloride, and hydrochloride of 5-thiopentylamine disulfide (III) that had been labelled with ^{35}S were injected into mice in the maximum tolerable doses, which were 125, 80, and 45 mg/kg, respectively. II was also injected intraperitoneally in a dose of 225 mg/kg. Compound III is a cystamine analog which does not exert a protective effect against radiation. As soon as 5 min after intravenous administration, I and II accumulated in significant amounts in the nuclei and mitochondria of liver and spleen cells, as shown by the radioactivity of the corresponding fractions from centrifuging of homogenates. The relative amount of II in the hyaloplasm was higher than that of I 5–15 min after injection of the compounds. On intraperitoneal injection of II in the higher dose, its content in the nuclei and hyaloplasm of the liver 10–30 min after administration was higher than that on intravenous injection in the lower dose, while there was no difference with respect to accumulation in mitochondria of the liver or nuclei, mitochondria, and hyaloplasm of the spleen. The amounts of ^{35}S found 10 min after administration of II were higher than those present 20 min later–i.e., II was eliminated rather rapidly from the tissues. III, which was administered in a lower dose than II because of its toxicity, accumulated mainly in the mitochondria of the liver and spleen. (JPRS)

36514 KINETIC METHOD OF INVESTIGATION OF THE RADIOPROTECTIVE EFFECT EXERTED BY INHIBITORS OF RADICAL REACTIONS. Belova, L. A.; Burlakova, E. B.; Kurganov, B. I.; Khrapova, N. G.; Shtol'ko, V. N. (Inst. of Chemical Physics, Moscow). Radiobiologiya, 7: 117-22(1967). (In Russian).

The possibility of determining the radioprotective activity of inhibitors of radical reactions on the basis of the deactivation kinetics of lactodehydrogenase in their presence under the effect of ionizing radiation was studied. Irradiation of the enzyme was carried out the γ rays at a dosage rate of 1250 rad/min in aqueous solutions in the presence of n-Pr gallate, iso-Pr gallate, 3-hydroxy-2-Et-6-Me-pyridine (HCl), 2-hydroxy-3-tert-Bu-phenylpropylamine (HCl), 3-hydroxy-2,4,6-tri-Me-pyridine, 4-hydroxy-3,5-di-tert-Bu-benzylamine (HCl), 4-hydroxy-3,5-di-tert-Bu-α-Me-benzylamine (HCl), and 2-hydroxy-3,5-di-tert-Bu-propylamine (HCl). It was established that the effect of the inhibitors (InH) in protecting the enzyme was correlated with constant k_7 of the reaction of the inhibitors with peroxide radicals $RO_2^{\cdot} + InH \xrightarrow{k_7} ROOH + In^{\cdot}$ rather than with their over-all antioxidant activity. The values of k_7 were determined on the basis of the capacity of the inhibitors to quench chemiluminescence in the initiated oxidation of ethylbenzene. The inhibitors with free OH groups had high values of k_7 and also exhibited a high activity in protecting the enzyme against radiation. (JPRS)

36515 RADIOPROTECTIVE ACTION OF INHIBITORS OF RADICAL PROCESSES IN EXPERIMENTS WITH TRANSFORMATION-ACTIVE DNA. Zhizhina, G. P. (Inst. of Chemical Physics, Moscow). Radiobiologiya, 7: 155-6(1967). (In Russian).

Transformation-active DNA isolated from Streptococcus challis bacteria resistant to streptomycin was irradiated with γ rays with and without addition of the radical process inhibitors n-Pr gallate (I) and 2-Et-6-Me-3-hydroxypyridine (II). Transformation of a recipient culture of S. challis was then carried out with the DNA and the activity of the latter estimated on the basis of resistance of the culture to streptomycin. I and II exerted a pronounced protective effect on the transformation-active DNA, reducing the loss of its activity on irradiation with doses in the 1–15 kR range. The radical process inhibitors 2,4,6-tri-Me-3-hydroxypyridine, 2,6-di-Me-4-dimethyl-aminomethyl-3-hydroxypyridine, and 2-Me-4,5-bis-hydroxymethyl-3-hydroxypyridine also protected the DNA against deactivation by radiation, although their protective effect was not as great as that of I and II. The protective action of the substances studied showed a correlation with their antioxidant activity. (JPRS)

36516 RESEARCHES ON THE EFFECTS OF ULTRAVIOLET RADIATION ON DNA, IN VITRO AND IN VIVO. Cremonese, Marta. Ann. Ist. Super. Sanita, 2: 824-9(1966). (In Italian).

The effects of uv radiation on DNA were investigated with respect to buoyant density in a CsCl gradient, interruptions in a single polynucleotide strand, and molecular fractions resistant to denaturation. For all of these effects a maximum of quantum efficiency at $\lambda = 2880$ Å was shown. The effect of starvation on Escherichia coli B before uv-irradiation suggested that the enzyme responsible for dark recovery was constitutive. (B.H.S.)

36517 INFLUENCE OF WHOLE-BODY X IRRADIATION ON HEME BIOSYNTHESIS IN VITRO BY HEMOLYZATES OF HEN ERYTHROCYTES. Kazueva, T. V. (Central Scientific Research Roentgenoradiological Inst., Leningrad). Radiobiologiya, 6: 817-18(1966). (In Russian).

The influence of whole-body X irradiation upon individual stages of heme biosynthesis was studied in vitro on specimens of peripheral blood from hens (10 controls and 40 irradiated at a dose of 600 roentgens). Enzyme fractions obtained from the hen erythrocytes at various periods after irradiation were incubated with radioactive iron and a substrate: glycine, δ-aminolevulinic acid, or free protoporphyrin. Phase changes in the heme biosynthesis of the irradiated animals were detected: a statistically significant increase in the incorporation of ^{59}Fe into hemin in samples with glycine and free protoporphyrin immediately after irradiation, followed by a drop to the normal level after 24 hours, then another significant increase on the third day, followed by another return to normal by the seventh day. The lack of inhibition of heme biosynthesis in enzyme fractions of erythrocytes following whole body irradiation of hens is contrasted to mammals, which show a distinct decrease in the heme biosynthesis in similar tests with various substrates. (JPRS)

36518 INFLUENCE OF IONIZING RADIATION ON THE PROPERTIES OF MONOMOLECULAR LAYERS OF CRYSTALLINE MYOSIN AND THE CHARACTERISTICS OF GEL FORMATION OF ITS SOLUTIONS. Egiazarova, A. R.; Nadareishvili, K. Sh.; Zaalishvili, M. M. (Inst. of Physiology, Tbilisi, USSR). Radiobiologiya, 6: 790-5(1966). (In Russian).

The properties of monomolecular layers of myosin solutions (concentrations of 1 to 55 mg/ml) were investigated immediately after x irradiation at doses of 1, 3, 10, 75, 100, and 140 kR. At all the concentrations studied, doses from 1 to 100 kR caused a decrease in the area and charge of the monomolecular layer. Irradiation at 100 kR caused fragmentation of the myosin molecule at a concentration of 1 mg/ml. Over the entire concentration range, the viscosity and elasticity of monolayers of myosin solutions irradiated at doses of 60 to 75 kR decreased in comparison with the nonirradiated protein. Beginning with 60 to 75 kR, the viscosity and elasticity of the monolayer at low surface pressures were equal to the elastic-viscous values of a monolayer of a nonirradiated myosin solution, while at high surface pressures they exceeded them. Gel formation was not observed in irradiated myosin solutions with low concentration (1 mg/ml). In protein solutions with concentrations above 4 mg/ml, a gel was formed after irradiation

at 100 kR. A liquid phase with a low protein content, comprising 16 to 30% of the initial amount in solution before irradiation, was isolated in this case. When myosin solutions were irradiated in a nitrogen atmosphere, gel formation occurred at the same doses as in the case of free access to atmospheric oxygen. (JPRS)

36519 SEASONAL VARIATIONS OF THE PROTEOLYTIC ACTIVITY OF THE RAT LIVER (pH 7.4) AND THE EFFECT OF PENETRATING RADIATION UPON THIS INDEX. Druzhinin, Yu. P. (Inst. of Medicobiological Problems, Moscow). Radiobiologiya, 6: 917-20(1966). (In Russian).

The postirradiation dynamics of the activity of neutral proteinases and peptidases of the rat liver under the action of x rays on endogenous substrates was studied. Monthly observations of the hourly increase in amino acid nitrogen in liver homogenates from intact rats during incubation with neutral proteinases and peptidases established a sinusoidal dependence on the time of year. The increase in proteolysis of the rat liver during the winter was correlated with an intensification of the basal metabolism. Then the influence of various doses of penetrating radiation (100 R of x rays at a dose rate of 55 to 60 R/min and 3 R at a rate of 11 to 12.75 R/min; 1600 R of γ rays at a dose rate 231 R/min) upon liver proteolysis was studied during the summer and winter periods. A wave-like variation was observed in the proteolytic activity of the liver after irradiation. During the summer, with a low initial level of proteolysis, radiation caused the appearance of repeated increases in proteolysis, while in the winter, with high initial values of proteolytic activity, irradiation led to repeated drops in the process. (JPRS)

36520 ANALYSIS OF THE PHENOMENON OF LOSS OF POTASSIUM IONS BY IRRADIATED CELLS. Nakhilynitskaya, Z. N. (Inst. of Medicobiological Problems, Moscow). Radiobiologiya, 6: 796-801(1966). (In Russian).

The processes of potassium ion transport in irradiated cells were studied in model experiments on rat erythrocytes, kept under conditions close to those in vivo. The values of the coefficients for potassium fluxes in the cell to plasma and plasma to cell direction were determined using the radioactive isotope ^{42}K. Gamma irradiation of fresh heparinized blood, as well as erythrocyte suspensions in buffer solution, at doses from 10 to 100 kR was found to lead to a change in the transport of potassium ions in both directions. In a 10-hour period following irradiation, two phases in the changes in the incorporation of ^{42}K into irradiated erythrocytes were observed. For one to two hours after irradiation, there was an increase in the rate of transport of potassium ions from the plasma into the cell; following a period of normalization, a second phase, a substantial inhibition of this process, is observed six to eight hours after irradiation. In the range from 10 to 50 kR, the increase in the incorporation of ^{42}K into irradiated erythrocytes was directly dependent on the irradiation dose; this dependence was not observed at higher doses. Transport in the opposite direction: the removal of potassium ions from irradiated erythrocytes, was increased in the irradiated cells in comparison with the controls. This phenomenon was found to develop during irradiation and progressed with time as a function of the radiation dose. When erythrocytes suspended in a sucrose solution were irradiated, followed by the addition of ^{42}K to the suspension, the phase of increased incorporation of the isotope into the cells was not observed. Incubation of the erythrocytes at 37° before irradiation resulted in more intensive incorporation of ^{42}K the greater the irradiation dose, and consequently the greater the loss of potassium ions by the irradiated cells. Chilling the erythrocyte suspension to 5° before irradiation likewise intensified the effects of irradiation. The latter findings, in conjunction with the sucrose experiments, indicate that the increased removal of potassium ions from the cell results in an activation of the penetration of potassium into the cell, according to a mechanism of restoration of Donnan equilibrium (there is no Donnan effect in a solution of sucrose, a nonelectrolyte). The increase in the rate of removal of potassium ions from irradiated cells is attributed to damage to the structure of the erythrocyte membranes, possibly intensified by an increase in the ionic potassium content in the cell. (JPRS)

36521 ON THE DIFFERENCE IN THE PARAMETERS CHARACTERIZING THE METABOLISM OF RADIOACTIVE AND STABLE CALCIUM AFTER BRIEF INCORPORATION OF THE RADIOISOTOPE. Dubrovina, Z. V.; Malkin, P. M. (Inst. of Biophysics, Moscow). Radiobiologiya, 6: 812-16(1966). (In Russian).

The balance of radioactive and stable calcium, the assimilation of ^{45}Ca from the intestines, and the elimination of both isotopes from the organism were determined in two series of experiments on rats. In the case of rats on a diet deficient in calcium, differences were observed in the retention and elimination of radioactive and stable calcium in short-term experiments: the retention of the ^{45}Ca was greater and the elimination lower than those of stable calcium. In the case of a diet with a calcium content at or above the normal physiological requirement, the retention and elimination of the radioactive and stable forms of calcium were the same. In view of this, it was concluded that in the case of a high calcium level assimilated from the diet, the elimination of the isotope originally deposited in the bones will be hindered. This conclusion is especially important in view of attempts of researchers to enhance the elimination of deposited radiostrontium by increasing the level of calcium in the diet. (JRPS)

36522 DIRECT AND DISTANT EFFECTS OF RADIATION ON THE LEVEL OF QUINONES IN ORGANS AND TISSUES OF RATS. Baltbarzdys, Z. Ya.; Bilushi, S. G.; Goida, E. A.; Kudryashov, Yu. B.; Kuzin, A. M.; Lebedeva, N. E. (Moscow State Univ.). Radiobiologiya, 7: 79-81(1967). (In Russian).

Upon irradiation of rats with γ rays at a dose of 900 R, the level of quinones in various organs and tissues of the irradiated animals (liver, kidneys, stomach, muscles, testis, and spleen) increased when compared with controls. A maximum in the level of quinones in the liver of the irradiated animals developed on the 1st to 2nd day after irradiation. When rats were irradiated with the same dose after their liver had been shielded with Pb, the resulting increase in the quinone content in this organ was much less pronounced, although a maximum in the quinone content after irradiation still developed. The results indicated that the increase in the quinone content of the liver was due mainly to a direct effect of radiation on this organ, but also to some extent to a remote effect consisting either of transfer of quinones from other organs or of a secondary reaction resulting in the formation of quinones. (JPRS)

36523 FORMATION OF QUINONES IN PLANTS WITH DIFFERENT RADIOSENSITIVITIES. Kuzin, A. M.; Norbaev, N.; Parpieva, G. (Inst. of Biological Physics, Moscow). Radiobiologiya, 6: 902-3(1966). (In Russian).

Cotton and pea seedlings and corn seeds, each from a pair of varieties differing in radiosensitivity, were used in a study of the quinone content and its changes under the influence of ionizing radiation. In all the species of radioresistant plants studied, the quinone concentration before irradiation far exceeded the concentration in the radiosensitive plants. After γ irradiation, the quinone concentration increased sharply in the radiosensitive varieties (by 44-87%), while the increase was much smaller in the radioresistant varieties (13-28%). It was hypothesized that the radioresistance of plants and their resistance to various diseases possess a common cause, which includes a high content of quinones in the radioresistant plants. Plants adapted by evolution to high endogenous quinone concentrations are less sensitive to an increase in these concentrations induced by irradiation; in plants with a low endogenous quinone level, such an increase causes a disturbance of metabolism. (JPRS)

36524 EXCHANGEABLE BONE CALCIUM. Rowland, R. E. (Argonne National Lab., Ill.). Clin. Orthop., No. 49, 233-48(1966).

Calcium-45 was administered intravenously to dogs, and they were sacrificed at times ranging from 12 minutes to several days later. Samples of bone for autoradiographic studies were stored in ethyl alcohol and later sectioned into 100-micron thick sections. Results are presented in the form of tables and graphs. Bone structures with the greatest exposure to the circulating fluids are the primary sites of rapid calcium exchange between blood and bone. Quantitation of autoradiographs made it possible to measure the quantity of calcium transferred from blood to bone at the various time intervals. It was found that the bone surfaces would be required to exchange an amount of calcium equivalent to that contained within 2,000 Å of the bone surface to account for the rapid deposit of ^{45}Ca on these surfaces. This exchange-depth was apparently the same in both dog and rabbit bone, but the former required 48 hours to label this volume fully, whereas the latter was fully labeled in only 4 hours. (H.L.W.)

36525 CHRONIC BERYLLIOSIS AND CALCOSPHERITE DEPOSITION. Sherwin, R. P.; Smart, R. H.; Scarborough, G. C. Arch. Environ. Health, 12: 237-45(Feb. 1966).

A case of berylliosis with concomitant formation of calcospherites, superficially resembling microlithiasis is reported. The patient had 5 years' exposure to beryllium just prior to the onset of respiratory symptoms, and autopsy revealed multiple fibrocollagenous nodules, consistent with healed beryllium granulomas. The calcospherite deposits, however, overshadowed the old granulomas. It was interesting to note that the calcospherites increased continuously in size as the confluent lesions diminished. It is suggested that the calcium deposits represent an unusual response to beryllium in an individual with an underlying predisposition to develop microlithiasis. It might be fruitful to review all cases of microlithiasis to determine if these had been direct or indirect beryllium exposures. (auth) (Occup. Safety and Health Abstr.)

36526 CHROMATOGRAPHY OF THE IRRADIATION PRODUCTS OF ERGOSTEROL. PART V. ISOLATION OF 3,5-DINITROBENZOATE OF VITAMIN D_2 FROM PHOTOLYSIS PRODUCTS OF ERGOSTEROL. Tulecki, Jerzy; Adamczewska, Zofia (Medical Academy Poznan, Poland). Diss. Pharm. Pharmacol., 19: 75-9(1967). (In Polish).

The products of the photolysis of ergosterol with uv radiation were determined. A 1.5% solution of ergosterol in benzene was irradiated with a type S 300 Hanau lamp, and the products were converted to the 3,5-dinitrobenzoate derivatives. Preliminary measurements of absorption curves and chromatographic column separation of standard solutions were performed before the column separation of photolysis products of ergosterol. Separation on aluminum oxide containing 5% water gave the 3,5-dinitrobenzoate of vitamin D_2 in 28.9% yield, and separation on activated silica containing 5% water gave vitamin D_2 in 30% yield (calculated on the basis of the tar after photolysis). Properties of the various other fractions that were obtained are described. (BBB)

36527 THEORETICAL ASPECTS OF THE UV INACTIVATION OF PROTEINS CONTAINING DISULFIDE BONDS. Dose, Klaus (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). Photochem. Photobiol., 6: 437-43(June 1967).

Equations are proposed for estimation of quantum yields for cystine destruction and disulfide protein inactivation during uv irradiation in acidic and neutral solutions. The formulas permit a discussion of energy transfer from excited aromatic amino acids to cystines and/or of chemical reactions between excited tryptophans or tyrosines and cystines. The results are discussed with regard to general aspects of the photochemistry of enzymes. It was demonstrated that the absorption of 2537 Å light by proteins can be computed from the number of chromophoric groups per molecule and the corresponding molecular extinction coefficients of the free amino acids. For the 5 proteins examined the computed extinction coefficients agreed with the experimental values to about 10% although their content in chromophoric groups was very different. It is therefore shown that in proteins the constituent chromophoric amino acids absorb 2537 Å light independently, and that the fraction of light absorbed by one species can be calculated by: $(n_i \times \epsilon_i/\epsilon_e) = f_i$, where n_i is the number of residues of amino acid, i, per molecule; ϵ_i is the molar extinction coefficient of each residue; ϵ_e is the molar extinction coefficient of the enzyme, and f_i is the fraction of light absorbed absorbed by the residue. (BBB)

36528 THE EFFECT OF ENVIRONMENT ON CYSTINE DISRUPTION BY ULTRAVIOLET LIGHT. Risi, Sergio (Max-Planck-Institut fuer Biophysik, Frankfurt am Main); Dose, Klaus; Rathinasamy, T. K.; Augenstein, Leroy. Photochem. Photobiol., 6: 423-36(June 1967).

When cystine was irradiated at pH 1 by 254-nm uv light, the following yields were observed: 4 cystines → 5.2 cysteines + 2.8 NH_3. Thus, SH production accounted for only 0.65 of the cystine destruction; further C–S breakage to give alanine or serine was not efficient. The yields for cystine and glutathione destruction were essentially the same at pH 1. However, the presence of the glutamic acid and glycine residues stabilized the cystine in glutathione so that NH_3 was not lost until the peptide bonds were hydrolyzed. Increasing the pH from 1 to 8.6 increased the yield of cystine destruction in glutathione by 50%. The yield of cystine destruction was greater in both compounds when O_2 was present during irradiation (e.g., the cysteic acid yield in glutathione was increased by 50 times). The overall production of SH varied by a factor of 2 in the 4 proteins studied (insulin, RNase, trypsin, and lysozyme). The data support the earlier observation that radiation damage is quite nonrandom in RNase: at least 2 and perhaps 3 of the 4 constituent cystines must be disrupted before activity is lost; i.e., the most radiosensitive cystines are not critical for enzymic activity. Similarly, in both trypsin and lysozyme the integrity of the most radiosensitive cystines does not appear to be critical for the retention of enzymic potential. In insulin, however, all 3 cystines appear to be crucial for activity and to have equal radiosensitivities. These differences in sensitivity of cystines in different proteins must depend specifically upon energy transfer and/or chemical interactions between the chromophoric groups. If yields were calculated on the basis of those quanta absorbed only in the cystines, values about 5 to 8 times greater than those in the model compounds cystine and oxidized glutathione were obtained. The yields of cystine destruction were much higher in those proteins which contain tryptophan. (BBB)

36529 BILIARY SECRETION OF IODINE IN CALVES. Yatvin, Milton B. (Univ. of Wisconsin, Madison); McCoy, John R.; Reece, Ralph P. J. Dairy Sci., 48: 490-2(Apr. 1965).

An average of 24.3% of the radioactivity appeared in the bile of calves within 24 hr after cannulation of bile ducts and injection of thyroxine-^{131}I. When a similar injection of labeled thyroxine was administered to intact calves, only 18.0% of the radioactivity appeared in the 24-hr fecal sample. Fecal iodine loss and other pathways for modification of thyroid function and radioiodine loss that could result in hypothyroidism are discussed. In the lactating cow a combination of such conditions as iodine loss through the milk, depressed thyroid activity resulting from glucocorticoid secretion, fecal iodine loss, and low iodine content in the diet could result in a transient hypothyroidism which might act as an inciting factor in the induction of cystic ovaries. (BBB)

36530 RELATIONSHIP OF POTASSIUM MEASURED AS ^{40}K TO THE MOISTURE AND FAT OF GROUND BEEF. Ward, G. M.; Johnson, J. E.; Tyler, T. R. (Colorado State Univ., Fort Collins). J. Animal Sci., 26: 298-301(Mar. 1967).

Use of ^{40}K measurements by γ spectrophotometry for determinations of the composition of meat was evaluated. Meat samples were obtained from cattle varying in age, weight, and dietary history. The contents of water, fat, and ^{40}K were determined in 42 samples of ground, boneless beef, including wholesale cuts for each of five cows. A significant difference was found between cows in K concentration on a fat-free basis but not between wholesale cuts within animals. The K content showed coefficients of variation of 9.0 and 14.7%, respectively, expressed on a fat-free basis or a fat-free dry matter basis. Potassium concentration of fat-free tissue declined with increases in fat content, apparently explained by a K content of adipose tissue which is lower than that found in muscle. The correlation between the K concentration and fat percentage was −0.94 and described by the regression equation; % fat = 73.8 − 18.6 times g K/Kg of boneless meat. The standard error for this equation was 5.12. (BBB)

36531 EXPERIMENTAL STUDY ON IRON METABOLISM IN PREGNANCY. Soejima, Takashi (Tokyo Univ.). Nippon Sanka-Fujinka Gakkai Zasshi, 18: 1-8(Jan. 1966). (In Japanese).

In order to elucidate the origin of anemia during pregnancy, ^{59}Fe-labeled dextran or rabbit serum labeled with ^{59}Fe was intravenously injected into pregnant rabbits. The disappearance time of ^{59}Fe from the blood, the percentage of ^{59}Fe incorporated into red blood cells, the iron content in different organs of the mother and fetus, and ^{59}Fe transfer to each organ were studied. The results obtained revealed that pregnant rabbits became anemic and that their serum iron decreased as the fetus grew; in puerperium they recovered to almost normal conditions. The disappearance time of ^{59}Fe-labeled serum was the shortest in pregnant rabbits and was longer in nonpregnant anemia, puerperium and nonpregnancy, respectively. Label serum was transferred to the fetus very rapidly and in large quantities. Dextran-^{59}Fe (Ferrobalt) was not transferred to the fetus immediately after intravenous injection, but was transferred as a physiological iron after being disposed of in the body of the mother or placenta. The percentage incorporation of ^{59}Fe-labeled serum into red blood cells reached a maximum more rapidly in pregnant mice than in nonpregnant mice; five days after the administration both became nearly the same and was lower than in nonpregnant-anemic mice. Iron-59 labeled serum was used more in the body of the mother in the first half of pregnancy, but in the latter half, more in the fetus. The iron content of fetal organs increased as the fetus grew. It was considered that in the body of the mother the iron turnover rate was accelerated by a deficiency that was due to the iron requirements and metabolism of fetus. (TSS) (NSA of Japan)

36532 ATMOSPHERIC TRANSFER OF ^{14}C: A PROBLEM IN FUNGUS TRANSLOCATION STUDIES. Reid, C. P. P.; Woods, Frank W. (Duke Univ., Durham, N. C.). Science, 157: 712-13(Aug. 11, 1967).

Carbon-14-labeled carbon dioxide that was released by respiration after glucose labeled with carbon-14 was applied to fungal mycelium was reabsorbed in highly significant amounts by distant mycelia and agar media in the same petri dishes. It was recommended that atmospheric transfer of carbon-14 be considered when labeled organic compounds are used to study translocation in fungi. (auth)

36533 TRITIATED THYMIDINE: EFFECT OF DECOMPOSITION BY SELF-RADIOLYSIS ON SPECIFICITY AS A TRACER FOR DNA SYNTHESIS. Wand, Martin (Carlsberg Foundation, Copenhagen); Zeuthen, Erik; Evans, E. Anthony. Science, 157: 436-8(July 28, 1967).

Tritiated thymidine underwent decomposition by self-radiolysis. It was shown by beta liquid-scintillation measurement and by autoradiography that the resultant breakdown products did not label DNA, but entered macromolecules, other than nucleic acid, contained in the cytoplasm. (auth)

36534 LANGERHANS CELLS: UPTAKE OF TRITIATED THYMIDINE. Giacometti, L.; Montagna, W. (Oregon Regional Primate Research Center, Beaverton). Science, 157: 439-40 (July 28, 1967).

After irradiation of the skin of the rhesus monkey with ultraviolet light, there was temporary suppression of the proliferating activity of the epidermal cells, followed by some hyperplasia and a striking increase in synthesis of DNA by Langerhans cells. Since Langerhans cells were observed to proliferate, they can no longer be considered to be worn-out melanocytes. (auth)

36535 THE UV PHOTOCHEMISTRY OF POLY U. Pearson, Mark Landell. Toronto, Univ. of Toronto, 1966. Thesis.

Ultraviolet irradiation of nucleic acids can lead to the formation of specific photoproducts among the pyrimidine bases called dimers (D) and hydrates (H). Such photoproducts may be the primary structural lesions responsible for the inactivation of the biological activity of irradiated nucleic acids. To adequately study the specific roles of D and H photoproducts in the uv inactivation of nucleic acids, it was necessary to be able to accurately measure their yield in irradiated polynucleotides. The present studies exploit a method for the direct measurement of the concentrations of D and H photoproducts formed in a model polynucleotide, poly U. The method involved pancreatic RNAase hydrolysis of irradiated (^{32}P) poly U to give specific fragments containing D and H photoproducts as well as unaffected U's. Separation of products by two dimensional paper chromatography followed by liquid scintillation counting allowed an accurate determination of product yields. The structures of the fragments in the RNAase hydrolysate were defined by enzymic and chemical methods. The hydrolysis products were U, H, DU, and DH, plus a surprisingly large yield of products containing more than one D. Using the RNAase technique, it was possible to study the yields of D and H photoproducts formed in poly U under a variety of conditions. For instance, it was found that U's in the doublestranded complex poly (A + U) were much more resistant to uv than those in the random coil poly U. The yield of H in poly (A + U) was reduced to about $\frac{1}{10}$ that in poly U, while the yield of DU was reduced by $\frac{1}{3}$. In addition, the kinetics of product formation seemed to indicate that hydrogen bonds in the duplex poly (A + U) were destroyed through dimer formation. This resulted in a localized region of denaturation near dimers within the irradiated complex. Two mathematical models were developed to predict the yield of D and H in poly U when the cross sections for the formation of these products are specified. These independent computer-based models gave similar results and approximated the experimental yields at long wavelengths of irradiation but not at short wavelengths. The models allowed for the demonstration of pre-existing photoproducts within the chain that could influence the rate of formation of adjacent products. Alterations of photochemical reaction rates by adjacent products were observed experimentally in a detailed study of the photochemistry of poly U itself over the wavelength range 225-289 mμ. Although the rates of hydration and total dimer formation in poly U were equal to those in UpU, indicating that the polynucleotide structure did not alter the gross rate of photochemical reactions of U, dimers were not formed at random throughout the chain but tended to appear together in clusters. The ready formation of these dimer-rich sequences suggested that there may be significant energy transfer within the poly U random-coil structure. (Dissertation Abstr.)

Ecology

Refer also to abstracts 36142, 36571, 36582, 36618, and 36747.

36536 (NP-16906) DISTRIBUTION OF ^{60}Co, ^{65}Zn, ^{85}Sr, AND ^{137}Cs IN A FRESHWATER POND. Environmental Health Series. Public Health Service Publication No. 999-RH-24. Brungs, William A. Jr. (Public Health Service, Rockville, Md.). Mar. 1967. 52p. Public Health Service Free.

Data were obtained on the chemical, ecological, and physical distribution of four radioisotopes added to a small pond. The conditions were comparable to those in an accidental release of radioisotopes to an impoundment. Cesium-137, ^{60}Co, ^{85}Sr, and ^{65}Zn were added to a 30,000-gallon pond, with a sand substrate, and containing experimental biota. The pond was lined with a single 8-mil sheet of black polyethylene. Sampling from the pond continued for 80 days. The quantities of isotopes were determined with a gamma-scintillation spectrometer. Supplemental chemical and biological information on the artificial pond and an adjacent control pond provided a measure of the differences between these two environments. Results of the experiment were evaluated with regard to plans for future work. After 4 days, 10% of the ^{60}Co, 6% of the ^{65}Zn, and 5% of the ^{137}Ce remained in solution. Cobalt-60 and ^{65}Zn were associated principally with suspended solids, and ^{137}Ce with bottom sediments. In general, soft parts of biota rapidly accumulated more radioisotopes than hard parts, but gradually lost radioactivity as radioisotope concentrations in the water decreased. Clam and snail shells and fish bone usually accumulated ^{65}Zn and ^{85}Sr until almost the end of the experiment. More ^{65}Zn than any of the other test radioisotopes was found in soft parts of biota. Strontium-85 activities usually exceeded those of ^{65}Zn in bone and shell. Young clams and snails accumulated more ^{65}Zn and ^{85}Sr than did adult clams and snails. Strontium-85 concentrations in the soft parts of clams were higher in the adults. The maximum observed accumulation of ^{85}Sr occurred in the crayfish exoskeleton. Maximum activities of the other test radioisotopes were observed in tadpoles. (auth)

36537 SUMMARY OF THE ECOLOGICAL EFFECTS OF NUCLEAR TESTING ON NATIVE ANIMALS AT THE NEVADA TEST SITE. Allred, Dorald M.; Beck, D. Elden; Jorgensen, Clive D. (Brigham Young Univ., Provo, Utah). Utah Acad. Sci., Proc., 42: 252-60(1965). (COO-1355-13).

Since 1959, some areas where nuclear detonations occurred were compared ecologically with similar areas which were undisturbed. Disturbed situations are considered as those where physical damage of the vegetation is readily visible and measurable. This varies from slight damage to complete elimination. Undisturbed areas are those where there is no visible damage. Some areas of study extended outward from ground-zero through transitional disturbed into undisturbed conditions where the dividing lines were difficult to delimit. At no time was radiation fallout included as an item of damage or disturbance in our studies. Blast effects and the effects of nuclear and thermal radiations were studied. Work is still in progress and further results will be published relative to native animals at the test site. The overall program of ecological studies is reviewed. (75 references.) (C.H.)

36538 EFFECTS OF CHRONIC GAMMA RADIATION ON THE STRUCTURE AND DIVERSITY OF AN OAK-PINE FOREST. Woodwell, G. M.; Rebuck, A. L. (Brookhaven National Lab., Upton, N. Y.). Ecol. Monogr., 37: 53-9(Winter 1967).

Chronic effects of ^{137}Cs γ radiation on an oak-pine forest over a 4-yr period were studied. Effects on the structure of the community were expressed best by change in diversity (number of species per unit land area). The population underwent a 50% reduction in diversity at 160 R/day during the first 6 months' exposure. Diversity continued to decline regularly. Reduction in diversity was systematic in that plants with large life-forms were most sensitive. This resulted in zonation of the vegetation around the ^{137}Cs source, five zones being conspicuous although not always clearly delineated. These were: a devastated zone close to the source where all indigenous higher plants were killed; a Carex zone where Carex pensylvanica was the principal survivor; a shrub zone where both Carex and the ericaceous shrubs survived; an oak-forest zone where the pines had been killed; and an oak-pine zone where the forest was intact. Survival of trees varied with tree size, an increase in size contributing generally to increased resistance because of the greater number of buds and because of the increased probability that certain buds would be shielded. Survival of buds as opposed to survival of trees was a particularly useful criterion of radiation damage. Radiation resistance was correlated with life forms of the plants, the most resistant being low-growing species. (BBB)

Genetics and Cytogenetics

Refer also to abstracts 36665, 36746, 36748, 36749, and 36751.

36539 (SAN-590-2) X-RAY INDUCED CHANGES IN DROSOPHILA GERM CELLS. Three-Year Comprehensive Report, September 1, 1964-August 31, 1967. Rinehart, Robert R. (San Diego State Coll., Calif.). Contract AT(04-3)-590. 62p. Dep. CFSTI.

Possible mutagenicity of irradiated Drosophila food and food supplements was investigated. The data support the following conclusions: irradiated Drosophila medium is mutagenic; medium supplemented with DNA or autoclaved sucrose is mutagenic whether irradiated or not; irradiated or nonirradiated nonautoclaved sucrose is not mutagenic; aging the food or food supplements does not significantly alter the mutation frequencies. Earlier reports of decreasing survival with extended anoxic treatments were substantiated when either attached-X or ring-rod heterozygous females were irradiated and posttreated with helium. Detachment frequencies increase with increasing anoxia. Effects of anoxia on the frequency of x-ray induced sex-linked recessive lethality and x-ray induced chromosome loss are described. Data indicate that the Y chromosome may be able to both suppress and enhance X chromosome lethality. (H.L.W.)

36540 MUTAGENIC ACTION OF UV ON THE OOGONIA OF DROSOPHILA. I. KINETICS OF THE MUTAGENESIS. Proust, Jacqueline (Univ., Paris, Orsay, France). Mutat. Res., 4: 473-89(July-Aug. 1967). (In French).

Data are reported on the rate at which recessive lethals are induced in Drosophila melanogaster oogonia by different doses of ultraviolet radiation. Ovarian primordia dissected out of third instar larvae were irradiated in vitro before implantation into the body cavities of host larvae and induced lethals were scored. The fertility of the implanted ovaries was lower than the controls. This effect was mainly due to the implantation rather than the irradiation although the latter contributed to the low fertility at the highest doses. The dose-effect relationship was not linear, the highest frequency of induced lethals was reached at 1000 erg/mm^2 with a significant drop at higher doses. This could be explained either by increased killing or by more dark repair of genetic damage due to a longer delay in DNA syntheses at the highest doses. (68 references.) (M,M,B)

36541 ON THE RELATIONSHIP BETWEEN THE FREQUENCY OF TWO TYPES OF MUTATION AND SOFT X-RAY DOSES IN DROSOPHILA. Matsudaira, Yoriaki (Rikkyo Univ., Tokyo); Ito, Takashi; Yamasaki, Terutoshi; Ishizaka, Shozo; Domon, Masaharu. Mutat. Res., 4: 469-72(July-Aug. 1967).

The dose frequency relationship for 2 types of mutation, fractional- and whole-body, was obtained using soft x rays on Drosophila melanogaster. At low doses (e.g., 400 R to 1440 R) more fractionals were induced than whole-body changes, whereas at high doses (e.g., 3000 R) the reverse relationship was observed. These results are in agreement with those of other investigations involving Drosophila and yeast. The origin of these mutations is discussed in relation to the strandedness of the DNA molecule of the gene. (auth)

36542 THE RELATIVE MUTAGENIC EFFECTIVENESS OF FAST NEUTRONS AND X-RAYS IN PRE- AND POST-MEIOTIC GERM CELLS OF DROSOPHILA MELANOGASTER. Lamb, Marion J.; McSheehy, T. W.; Purdom, C. E. (Medical Research Council, Harwell, Eng.). Mutat. Res., 4: 461-8(July-Aug. 1967).

Adult male Drosophila melanogaster were irradiated with doses of up to 1000 RAD of x rays or neutrons (+10% γ rays) and germ cells irradiated at pre-meiotic and post-meiotic stages were tested for the presence of IInd chromosome recessive lethals by the Cy/Bl L method. Lethal mutations found in sperm irradiated at the premeiotic stages were tested for allelism. A satisfactory fit to a linear dose response was obtained for x rays and neutrons in each germ cell stage. In post-meiotic germ cells, the mutation frequency was 4.35×10^{-5} per RAD for x rays and 9.77×10^{-5} per RAD for neutrons with an RBE of 2.24. For pre-meiotic germ cells the mutation frequency for x rays was 1.36×10^{-5} per RAD and 2.80×10^{-5} per RAD for neutrons with an RBE of 2.05. There was no evidence that the RBE differed for the two types of germ cells. (auth)

36543 RADIATION-INDUCED LETHAL SECTORING IN ESCHERICHIA COLI B/r AND B_{s-1}. Haefner, K.; Striebeck, Ute (Southwest Center for Advanced Studies, Dallas). Mutat. Res., 4: 399-407(July-Aug. 1967).

The fate of the descendents of irradiated bacterial cells was investigated by means of micromanipulatoric pedigree analysis. After UV irradiation of Escherichia coli B/r as well as B_{s-1}, a considerable amount of inactive descendents was found in the first four postirradiation generations. X radiation induced such inactive cells (lethal sectors) only in B_{s-1}. The data resemble in several respects the observation of lethal sectoring in yeast. Two models proposed to explain lethal sectoring are discussed. (auth)

36544 X-CHROMOSOME LOSS INDUCED BY LOW X-RAY DOSES IN MATURE AND IMMATURE OOCYTES OF DROSOPHILA MELANOGASTER. Traut, H. (Univ. of Muenster, Ger.). Mutat. Res., 4: 510-13(July-Aug. 1967).

A comparison was made of the radiosensitivity of Stage 14 and Stage 7 oocytes of Drosophila by measurement of x radiation induced x-chromosome loss in offspring originating from oocytes irradiated in both stages. It was demonstrated that in the dose range from 0 to 400 R the frequency of x-chromosome loss is about 30 times higher for Stage 14 than for Stage 7. The results may be utilized as an argument for the high efficiency of Stage 7 oocytes in repairing radiation-induced chromosome breaks. (M.M.B.)

36545 A REMARK TO THE ORIGIN OF PURE MUTANT CLONES OBSERVED AFTER UV TREATMENT OF SCHIZOSACCHAROMYCES POMBE. Haefner, K. (Southwest Center for Advanced Studies, Dallas). Mutat. Res., 4: 514-16(July-Aug. 1967).

A question basic to the mutation-induction process is whether both or only one strand of the DNA is altered by mutagen treatment or possible subsequent intracellular events. After uv-irradiation of Schizosaccharomyces pombe (adenine-requiring) many of the resulting colonies contained all mutant cells. Experiments were conducted to determine whether these colonies could result from lethal sectoring. It was found that although many of the pure mutant clones result from only one active cell in the first post-irradiation generation, some arose from cells which did not show lethal sectoring. (M.M.B.)

36546 THE MUTAGENIC EFFECT OF 600 MeV PROTONS IN DROSOPHILA MELANOGASTER. Lamb, M. J. (Medical Research Council, Harwell, Eng.); McSheehy, T. W.; Purdom, C. E.; Baarli, J.; Sullivan, A. H. Int. J. Radiat. Biol., 12: 27-34(1967).

Comparisons were made between the mutagenic efficiency in Drosophila of 600 MeV protons and 250 kVp x rays. Second chromosome recessive lethal mutation frequencies were measured in 6 successive 3-day broods of offspring. There was no evidence of any difference between the effectiveness of x rays and protons from the initial beam or from the Bragg peak region of the beam in inducing mutations in any of the germ cell stages sampled. (auth)

36547 CORRELATION BETWEEN CHROMOSOME ABERRATION AND MORPHOLOGO-PHYSIOLOGIC MODIFICATIONS OF MAIZE IN M_1 IN CASE OF SEED IRRADIATION. Ozol, A. M.; Eizenberga, V. T. (Inst. of Biology, Riga). Latv. PSR Zinat. Akad. Vestis, No. 3, 96-100(1967). (In Russian).

The chromosomes of meristem cells of primary roots of the Meleksberger-28, Minsk-1, and Bukovinskii-3 hybrids were studied in order to determine the relation between chromosome anomalies and morphological-physiological alterations in the first generation plants cultivated from γ- and fast neutron-irradiation seeds. The tabulated data of the investigation with seeds irradiated with 10 and 20 kR γ rays and 1.0 to 2.0 kR fast neutrons showed that the weight and height of the plants diminished with increased doses. The survival of the plants was also reduced, and the percentage of albino, angustifoliate, and dwarf plants was higher than among the controls. However, in the Bukovinskii-3 hybrid strain such pronounced differences were not observed. A relation between the radioinduced damage of chromosomes of the first meristem cells of the primary root and the subsequent morphological-physiological changes in plants of the M_1 generation was confirmed. (R.V.J.)

36548 SATURATION OF THE DOSE-RESPONSE CURVE FOR CHROMOSOME EXCHANGES IN TRADESCANTIA MICROSPORES. Savage, John R. K. (Medical Research Council, Harwell, Eng.). Mutat. Res., 4: 295-306(May-June 1967).

Dose response curves for chromosome exchanges in Tradescantia paludosa microspores were obtained using 0.7 MeV fast neutrons or 250 kVp x rays. The neutron curve showed clear evidence of saturation, and gave 2.18 for the value of N, the mean number of effective sites for exchange. When corrections were made for factors other than site limitation that will contribute to saturation, the value of N increased to 2.7. In contrast, the x-ray curve, although reaching a maximum exchange yield only 0.2 per cell below that attained for neutrons, showed no evidence of saturation. The difference may best be interpreted in terms of differences in the numbers of exchange sites. The question remains as to whether this difference was intrinsic in the cells, or a reflection of qualitative differences between the radiations. In the former case, a mean number of 2.7 effective exchange sites per cell existed for neutrons, but considerably more for x rays and might indicate that the two radiations act at different sites. In the latter case two possibilities existed. The predominantly one-track nature of exchange formation with high LET radiations means that only a proportion of the actual size present were available to neutrons. The proportion would consist of smaller sites where the probability of producing lesions in both threads with a single track of high LET was high. Although less efficient on a per track basis, x-rays have a large two-track component at higher doses, and would not be confined to the smaller sites, and would therefore have more sites available. The important factor may not be the number of sites available, but the existence of a progressive inactivation of sites (with consequent reduction in the number of exchanges produced) as the dose was increased. If the efficiency of inactivation was greater at higher LET, the dose-response curve would have saturated more quickly, and could be interpreted as a lower number of effective sites. (auth)

36549 CHROMOSOME STUDIES ON MARSHALL ISLANDERS EXPOSED TO FALLOUT RADIATION. Lisco, Hermann (New England Deaconess Hospital, Boston. Harvard Univ., Boston); Conard, Robert A. Science, 157: 445-7(July 28, 1967). (BNL-11257).

Cytogenetic studies of blood lymphocytes of Marshall Islanders, 10 years after their exposure to radiation from fallout in 1954, showed chromosome-type aberrations in 23 of 43 exposed persons. Half the aberrations were of the exchange type. An unexpectedly

large number of acentric fragments, but no exchange-type aberrations, appeared in a few unexposed people on the same island. (auth)

36550 ELECTRON MICROSCOPIC INVESTIGATIONS ON PLASMON ALTERATIONS OF EPILOBIUM HYBRIDS. PART II. OCCURRENCE OF SPHERICAL PARTICLES IN THE PLASMA OF EPILOBIUM SPECIES AND PLASMON CHANGES OF E. HIRSUTUM ESSEN ♀ X E. PARVIFLORUM TUEBINGEN ♂ HYBRIDS. Anton-Lamprecht, I. (Max-Planck-Institut fuer Zuechtungsforschung, Cologne). Z. Vererb., 98: 257-69(1966). (In German).

The distribution of spherical particles in the assortment of Epilobium species and hybrids was examined in 70 clones. It was found that spherical particles were present only in the descendants of certain lines of E. parviflorum Tübingen. There existed no correlation with the cytoplasmic alteration of irregulare. The female parent of the hybrids, E. hirsutum Essen, was found to be constantly free from spherical particles. Spherical particles were present in those clones that ascended from crosses with the line p.T.8 of the original race E. parviflorum Tübingen, for instance, crosses with p.T.8 treated with β particles (^{32}P, ^{35}S, Mesothorium I). They were missing in those clones that ascended from crosses with x-ray induced mutants of parviflorum Tübingen, for instance, p.T. resistens or p.T. normalisatum. (auth)

Health Physics and Safety

Refer also to abstracts 35855–35859, 36100, 36357, 36480, 36739, 37195, 37202, 37285, 37516, 37544, 38826, and 38844.

36551 (AD-635492) DESCRIPTION OF URBAN AREAS FOR FIRE ANALYSIS. Final Report. Salzberg, F.; Pintar, A. J.; Vodvarka, F. J. (IIT Research Inst., Chicago, Ill.). Mar. 1965. Contract DCA-8. 37p. CFSTI.

For various land use categories, typical blocks and structures were developed for describing an urban area in terms of parameters pertinent to the analysis of fire damage. Information employed consisted of the data from Sanborn maps, supplied by Dikewood Corporation, and reports of the Cook County and Illinois Inspection and Rating Bureaus. Inquiries were also sent to all cities in the United States having population of 100,000 or more, regarding the data available for identification of physical characteristics of structures. (auth) (CFSTI)

36552 (AD-636646) RADIONUCLIDES PRODUCED IN MAN BY HIGH ENERGY PROTONS. Scientific Report No. 1. Haller, I. B.; Jung, B. (Uppsala Univ. (Sweden). Gustaf Werner Inst. for Nuclear Chemistry). Nov. 18, 1963. Contract AF 61(052)-740p. 34p. CFSTI.

The activity of radionuclides produced by 150-MeV protons in targets of the elementary composition of the human brain and the whole human body was calculated from known or estimated spallation cross sections. The absorbed radiation dose due to delayed nuclear disintegrations was also estimated. (TAB)

36553 (AD-636647) CROSS SECTION FOR THE PRODUCTION OF (30)P FROM (31)P BY PROTONS OF ENERGIES BELOW 190 MeV. Scientific Report No. 3. Malborg, P. (Uppsala Univ. (Sweden). Gustaf Werner Inst. for Nuclear Chemistry). Dec. 1964. Contract AF 61(052)-740. 26p. CFSTI.

The excitation function for the production of ^{30}P from ^{31}P by protons between 20 and 190 MeV was measured. The sum of the cross sections of the reactions leading to the production of ^{30}P from ^{31}P was found to rise from threshold to a maximum of 50 to 100 millibarns between 15 and 50 MeV. At higher energies there was a continuous decrease to (32 plus or minus 5) millibarns at 100 MeV and (25 plus or minus 4) millibarns at 180 MeV. The result has some bearing upon the significance of ^{30}P as a contributor to the delayed radiation dose after irradiation of tissues with high-energy protons. The conclusion is drawn that ^{30}P should not be regarded important from this aspect as compared with the dominating radionuclides ^{15}O, ^{11}C, and ^{13}N. (TAB)

36554 (AD-636648) RADIOACTIVITY OF HUMAN BLOOD AS A MEASURE OF INTEGRAL DOSE FROM HIGH ENERGY PROTONS. Scientific Report No. 4. Graffman, Sten; Jung, Bo (Uppsala Univ. (Sweden). Gustaf Werner Inst. for Nuclear Chemistry). Dec. 1964. Contract AF 61(052)-742. 15p. CFSTI.

The carbon-11 radioactivity of blood samples taken from patients undergoing tumor therapy with high energy protons was measured. The results indicate that the blood radioactivity may be a good measure of integral radiation dose from high energy protons. Future developments are discussed briefly. (CFSTI)

36555 (AD-650927) EXTENSION OF THE GENERAL SENSITIVITY ANALYSIS. VOLUME I. METHODOLOGY. Final Report. McMullan, Philip S.; Cruze, Alvin M. (Research Triangle Inst., Durham, N. C. Operations Research and Economics Div.). Mar. 15, 1967. Contract OCD-PS-64-56. 70p. (R-OU-230-2(Vol.1)). CFSTI.

The final report, Extension of the General Sensitivity Analysis, consists of three volumes. Volume I, Methodology, discusses the methodology derived for civil defense sensitivity analysis and the results of demonstration runs employing the methodology on a statewide basis. Volume II, Technical Appendixes, gives details on derivations of the analytical expressions in the model. Volume II also reports: supplementary sensitivity analyses using the model on a limited basis; and sensitivity analysis of population exposure to nuclear weapons effects. Volume III, The ANCET Computer Program, reports on the detailed structure of the FORTRAN computer model used to calculate casualties for the sensitivity analyses. The objective of the research reported is to perform Civil Defense System sensitivity analyses which are designed to indicate the relative importance of the parameters used in total civil defense systems evaluation. The following questions must be answered for each parameter: Is the ranking of the effectiveness of civil defense systems altered as the parameter is varied over its range of uncertainty? When the answer to question is affirmative, can further research clarify or narrow the range of uncertainty? Can systems evaluation methodology be altered to reduce the importance of uncertainty? Should systems analyses report effectiveness for several values of the parameter? To assist in these analyses, a rapid-running computer model was designed to estimate casualties from a nuclear attack. The model's main features and broad outlines of operation are presented. (auth) (CFSTI)

36556 (AD-650928) EXTENSION OF THE GENERAL SENSITIVITY ANALYSIS. VOLUME II. TECHNICAL APPENDIXES. Final Report. Cruze, Alvin M.; Read, Campbell (Research Triangle Inst., Durham, N. C. Operations Research and Economics Div.). Mar. 15, 1967. Contract OCD-PS-64-56. 199p. (R-OU-230-2(Vol.2)). CFSTI.

Volume I, Methodology, discusses the methodology derived for civil defense sensitivity analyses and the results of demonstration runs employing the methodology on a statewide basis. Volume II, Technical Appendixes, gives details on derivations of the analytical expressions in the model and supplementary information on the analyses reported in Volume I. In order to perform calculations necessary for sensitivity analyses, an analytical computer model, called ANCET, was designed. The model computes both prompt effects and fallout casualties from a thermonuclear attack. The derivation of the analytical expressions for the prompt effects component model is reported in this volume. Analytic procedures for adapting the WSEG-10 fallout model for use as the ANCET fallout component model are also presented. Sensitivity analyses of the effect of the choice of parameters of the prompt effects casualty function show that casualty estimates are sensitive both to the choice of casualty function and to the assumed yield of the Japanese detonations. A sensitivity analysis of the exposure of population located both in circular urban areas and in circumferential rings to blast overpressure levels from nuclear detonation is also given. (auth) (CFSTI)

36557 (AD-650929) EXTENSION OF THE GENERAL SENSITIVITY ANALYSIS. VOLUME III. THE ANCET COMPUTER PROGRAM. Final Report. Cruze, Alvin M.; Wilkerson, Dora B.; Woodside, Mary B. (Research Triangle Inst., Durham, N. C. Operations Research and Economics Div.). Mar. 15, 1967. Contract OCD-PS-64-56. 210p. (R-OU-230-2(Vol.3)). CFSTI.

Detailed structure is reported of the FORTRAN computer model utilized to perform the casualty calculations for the sensitivity analyses. The model is designed specifically to assist in performing national sensitivity analyses of total Civil Defense Systems. The model, known by the acronym ANCET, features simplified input data variation and rapid computation of the expected number of casualties from a specified attack. These are accomplished by the use of readily varied analytical expressions throughout the model. These expressions approximate areal population and shelter distributions, prompt effects casualty functions, and various relationships in the fallout model. Included are: instructions for preparation of program input; detailed flow diagrams and verbal descriptions of each of the program subroutines; a description of program output, and a FORTRAN listing of each of the model subroutines. (auth) (CFSTI)

36558 (AD-650930) PROTECTION ANALYSIS AND CONSTRUCTION EVALUATION SYSTEM. Final Report, January 13, 1965–January 15, 1966. Bryan, F. A. Jr.; Hill, E. L.; Howard, B. W.; Johnson, T.; Lyday, R. O. (Research Triangle Inst., Durham, N. C. Operations Research and Economics Div.). Contract OCD-PS-65-47. 31p. (R-OU-205). CFSTI.

The task assignments in this project were principally concerned with the implementation of a CDC-3600 computer program for computing PF's of structure (PF-COMP) as well as with additions

to the program which would make it more useful to architects and engineers. The program was implemented by The Research Triangle Institute (RTI) through the Office of Civil Defense first in the performance of the Military Overseas Shelter Survey (MOSS) and subsequently in the analysis of federal buildings designated by the Office of Civil Defense. Finally, implementation of the computer program as a service to qualified fallout shelter analysts was performed in the Shelter Analysis for New Designs (SAND) program. A principal addition to the PF-COMP computer program that will render it more useful to architects and engineers consisted of an analytical routine for cost effectiveness modification of structures to improve basement shelter PF. Incorporated as a subroutine in this supplementary program is a technique that permits definition of shelter boundary as a function only of percentage roof contribution and shelter location within a structure. (auth) (CFSTI)

36559 (AD-651010) TRIAL SURVEY AND ANALYSIS OF SEVERAL BUILDINGS RELATIVE TO THEIR REUSABILITY AFTER A WAR FIRE. Final Report. Adams, Ray; Stubbs, Ian R. (Lin (T. Y.) and Associates, Van Nuys, Calif. Stanford Research Inst., Menlo Park, Calif.). May 1966. Contract OCD-PS-64-201. 84p. CFSTI.

Computer programs were developed for surveys of buildings relative to external fire exposure, interior fire load, ASTM fire rating of components and of the building's post-warfire reusability. Thirteen Los Angeles area buildings were surveyed and analyzed, and results appear to be reasonable. The accompanying user's manual provides step-by-step instructions for guidance of persons making building surveys to gather input data for the program. Pertinent conditions of, in, and around buildings, terminology, and surveying and data recording techniques are given in detail. (CFSTI)

36560 (AD-651167) COST AND FINANCING OF CIVIL DEFENSE: SOME PUBLIC VIEWS. Coleman, Alan N. (Pittsburgh Univ., Pa. Dept. of Sociology). Feb. 1967. Contract DAHC20-67-C-0122. 77p. CFSTI.

An attempt is made to bring together, from a number of national and community studies, the results regarding the American public's views on the cost and financing of civil defense measures and programs. Given the limitations imposed by the number and diversity of the studies used, the following generalizations were obtained: increasing civil defense expenditures in general is believed desirable; many citizens are uncertain about what fallout protection should cost; personal assumption of the total or even partial cost for family shelters is not favored; major objections to family fallout shelters involve cost; favorability of public as well as family fallout shelters is increased when federal or state financial assistance is included; a substantial portion of the citizenry favors a tax reduction or exemption for shelters; indirect inducements for building shelters generally meet the approval of the public; specified alternative methods of financing shelters have been met with disapproval or uncertainty; public shelters are viewed as effective and worth the cost; among alternative programs, education and health rank ahead of civil defense measures, and very few people currently agree that civil defense monies would be better spent on missiles and bombers. The majority of the studies utilized were conducted in the early 1960's, a time when the family shelter controversy reached its apex. General cost and financing issues and alternatives have not been probed extensively in national and community surveys. (TAB)

36561 (AECL-2678) ANALYSIS OF EXTERNAL RADIATION EXPOSURES IN 1966. Knight, G. B.; Adair, B. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Feb. 1967. 17p. Dep. CFSTI. CAN $0.50.

An analysis of occupational radiation exposures received by workers at AECL sites in 1966 was carried out by machine accounting methods. Results are presented in tables and graphs. (auth)

36562 (BNL-11613) RADIOACTIVE CONTAMINATION OF THE ATMOSPHERE, SOILS, AND AGRICULTURAL PRODUCTS IN KOREA, 1961-1966. Bai, Daihan (Brookhaven National Lab., Upton, N. Y.). [1967]. 22p. (CONF-670503-19). Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

Between 1961 and 1966, coinciding with the resumption of nuclear tests by the U.S.S.R. on September 1, 1961, and including the U.S. test series in 1962 and the three nuclear explosions by Communist China, radioactivity in air, dust, rain, soils, crops, and milk has been measured systematically throughout the country of Korea. The results covering six years are summarized in tables and figures and biological hazards are evaluated. In general, radioactive contamination can be traced principally to the nuclear detonations by Russia and Red China since the highest atmospheric contaminations have occurred within a few days of tests by these countries, although an appreciable amount of radioactivity was also detected in Korea following the U.S. tests. The highest levels of total beta-gamma activity measured in samples from various sources were 5.98×10^{-12} μc/cc of air in December 1962, 54.7×10^{-4} μc/cc of rain in October 1964, 57.37×10^{-4} μc/ft^2 of dust in October 1964, 28.65×10^{-4} μc/gr of soil in October 1963, 4.44×10^{-4} μc/gr of plants in October 1964, 3.6×10^{-8} μc/cc of tap water in July 1963, and 4.25×10^{-5} μc/cc of milk in June 1963. (auth)

36563 (BNWL-439) EVALUATION OF RADIOLOGICAL CONDITIONS IN THE VICINITY OF HANFORD FOR 1966. Essig, T. H.; Soldat, J. K. (eds.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1967. Contract AT-(45-1)-1830. 40p. Dep. CFSTI.

Surveys of the Hanford environment in 1966 showed that both the concentrations of radioactive materials in the vicinity and the environmental radiation doses were within appropriate limits. The major source of low-level wastes released to the environment from Hanford plants was reactor cooling water, which was discharged to the Columbia River. Two events occurred during 1966 that significantly influenced radiation levels in the Hanford environs. The first of these was an abnormal release of radioiodines from a production reactor to the Columbia River on February 11, 1966. The net effect of this release was to increase the thyroid dose to the Typical Richland Child from 6% of the limit (1965) to 9% of the limit (1966). The second event resulted in a significant reduction of radiation levels in the Hanford environs during a two month period. A strike was called against Hanford contractors on July 8, 1966. Within a few days, all reactors were shut down and remained out of operation until late August. The effect was to reduce the estimated annual doses to the GI tract, whole body, and bone by as much as 2% of the appropriate limits from the 1965 values. The Typical Richland Resident received most of his radiation dose from natural background and world-wide fallout. The radiation dose from Hanford sources received by this population group originates, for the most part, from drinking water obtained from the Columbia River. During 1966 the unusual release of radioiodines resulted in an estimated maximum thyroid dose of 40 mrem. The Chinese weapons test on May 9 and the Chinese and Russian nuclear tests on October 27, 1966, caused brief increases in ^{131}I concentrations in the environment, but concentrations soon returned to the low levels experienced during most of 1966. Appropriate radiation dose standards for individuals and population groups in uncontrolled areas are presented. (H.L.W.)

36564 (BNWL-SA-962) PROMPT MITIGATORY ACTION AFTER ACCIDENTAL EXPOSURE TO RADIONUCLIDES. Held, K. R.; Henle, R. C.; Selby, J. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1966]. Contract AT(45-1)-1830. 11p. (CONF-670521-7). Dep. CFSTI.

From Symposium on Diagnosis and Treatment of Deposited Radionuclides, Richland, Wash.

A variety of manufacturing and research and development programs involving several isotopes and several chemical forms of plutonium is conducted at Hanford involving approximately 20 percent of the 10,000 project employees. Accidents associated with such work require prompt analysis and action by trained radiation protection personnel to assure rapid evaluation of the internal exposure potential and to facilitate therapeutic treatment to minimize deposition within the body. Procedures for the initial screening, reporting, and evaluating of the severity of the accident and the liaison established between medical, Atomic Energy Commission, regulatory, and radiation protection personnel are briefly discussed. The effectiveness of decontaminating procedures, based on actual experience at Hanford, is reviewed. (auth)

36565 (BNWL-SA-963) DEVELOPMENT OF AN OCCUPATIONAL EXPOSURE RECORD SYSTEM TO SUPPORT ADVANCEMENT OF INTERNAL EXPOSURE EVALUATION TECHNOLOGY. Selby, J. M.; Held, K. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 4, 1967. Contract AT(45-1)-1830. 8p. (CONF-670521-8). Dep. CFSTI.

From Symposium on Diagnosis and Treatment of Deposited Radionuclides, Richland, Wash.

Extensive data on any accidental intake of radioactive material that may result in internal exposure, including a description of the accident, nature and characteristics of the contaminant, and an evaluation of the exposure are normally included in the Occupational Exposure Record of an individual. Both the complexity and quantity of data collected as the result of an accidental intake of radioactive material were increased at Hanford in light of recent changes in internal exposure evaluation techniques and the absence of certain types of data from past records that might be useful in studies to extend the deposition evaluation technology.

Types of additional data to be accumulated include estimates of critical organ and lung depositions based on instrument measurements, particle size analyses of the airborne contaminant and residual nasal contamination associated with the incident, and the chemical characteristics of the contaminant. Recent trends in data accumulation based on past experience and projected uses are discussed. (C.H.)

36566 (BNWL-SA-997) INTERPRETING COUNTING DATA FOR INTERNALLY DEPOSITED PLUTONIUM. Swinth, K. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 14, 1967. Contract AT(45-1)-1830. 26p. (CONF-670521-9). Dep. CFSTI.

From Symposium on Diagnosis and Treatment of Deposited Radionuclides, Richland, Wash.

Sensitive scintillation counters are presently being developed that will permit the measurement of internally deposited plutonium by counting the low-energy photons emitted (17 keV x rays, 60 keV ^{241}Am γ) by the plutonium. Interpretation of counting data will be influenced by three general factors; the change in photon emission rate with variable isotopic composition, the low penetrating power of the radiations, and the variable background due to high-energy radiations of other isotopes. The half-value thickness of tissue for 17 keV plutonium x rays is only 0.6 cm; and, because of this, factors changing the absorption such as internal distribution, surface contamination, and variable overlying tissue masses affect the interpretation of counting data. Data from phantoms and animals indicate the relative importance of these factors. Methods of correcting for these effects are discussed. For low-level counting, background variations are critical and data show that differences in low-energy (~17 keV) backgrounds of greater than a factor of two can be expected. This variable background is caused primarily by the contribution from other internal radionuclides and can be correlated with count rates in other energy regions. (20 references) (auth)

36567 (BNWL-SA-1232) TISSUE ANALYSIS FOR PLUTONIUM AT AUTOPSY. Newton, C. E. Jr.; Larson, H. V.; Heid, K. R.; Nelson, I. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.); Fuqua, P. A.; Norwood, W. D. (Hanford Occupational Health Foundation, Richland, Wash.); Marks, S.; Mahony, T. D. (Kadlec Methodist Hospital, Richland, Wash.). [1966]. Contract AT(45-1)-1830. 18p. (CONF-670521-5). Dep. CFSTI.

From Symposium on Diagnosis and Treatment of Deposited Radionuclides, Richland, Wash.

When radiation work includes chronic exposures to plutonium aerosols varying in activity, particle size and compound, a satisfactory assessment of internal depositions may not be obtainable on an individual basis. One method, which circumvents many unknowns and that can serve as a guide in estimating the effectiveness of deposition prevention practices, is the determination of plutonium in various organ tissue through a program of tissue sampling and analysis at autopsy. Such a program was started at Hanford in 1949 to obtain samples from both former workers and local residents. Of forty-one radiation workers having the same potential for plutonium deposition, small but measurable amounts of plutonium were found in most lung and liver samples. In only one case was measurable plutonium found in bone, and in two cases measurable quantities were found in lymph nodes. In only one of these cases did the results of the routine bioassay program suggest the presence of plutonium in the body. Extrapolation of measured amounts in liver using standard man parameters results in estimated liver burdens at death ranging from 0.5 to 60 picocuries plutonium-239. Similarly, measurable amounts in lung would indicate lung burdens at death 0.2 to 30 picocuries of plutonium-239. (auth)

36568 (BNWL-SA-1253) TREATMENT OF PLUTONIUM-CONTAMINATED WOUNDS WITH DIETHYLENETRIAMINEPENTAACETIC ACID IN RATS. McClanahan, B. J.; Kornberg, H. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 31, 1967. Contract AT(45-1)-1830. 9p. (CONF-670521-10). Dep. CFSTI.

From Symposium on Diagnosis and Treatment of Deposited Radionuclides, Richland, Wash.

Skin lacerations were contaminated with plutonium citrate, dioxide, or nitrate and then irrigated with DTPA to determine its efficiency in decontaminating wounds. No marked decontamination of the wounds was observed, but the plutonium content of urine indicated that some chelation had occurred. The absorption of the ^{239}Pu chelate formed with DTPA was measured to estimate the retention of any plutonium chelated and absorbed during wound irrigation. Approximately 85% of the plutonium was excreted in the urine in the first 24 hours. (auth)

36569 (BNWL-SA-1345) PLUTONIUM HANDLING SAFETY IN THE PLUTONIUM RECYCLE PROGRAM. Wittenbrock, N. B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 3, 1967. Contract AT(45-1)-1830. 26p. (CONF-670713-2). Dep. CFSTI.

From 3rd Meeting of the Reactor Operations Division of the American Nuclear Society, Atlantic City, N. J.

Conduct of the Plutonium Recycle Program demonstrated that plutonium-bearing fuels can be fabricated and irradiated safely. The incidents described at the Plutonium Fuels Laboratory and Plutonium Recycle Test Reactor showed that the contamination control system provided for these facilities can satisfactorily confine the plutonium in a less than maximum accident. Irradiation and tests in critical facilities verified estimates and provided data for refinement of the values for physics constants important to nuclear safety, such as the delayed neutron fraction and the neutron lifetime. (H.L.W.)

36570 (CONF-670313-2) ENRICHMENT OF RADIOACTIVITY BY LAPPS AND REINDEER. Miettinen, Jorma K. (Helsinki Univ. (Finland). Dept. of Radiochemistry). [1967]. Contract AT(30-1)-3446. 15p. Dep. CFSTI.

From International Conference on Environmental Radiological Protection Connected with the Development of the Peaceful Uses of Nuclear Energy, Toulouse, France.

The Finnish reindeer-herding Lapps were counted by a mobile whole body counter in winter 1966. Body burdens were on the average 1.2 μCi of ^{137}Cs or 55 times more than the average for the rest of the population. Maximum, 1.5 μCi, was obtained in 1965. It was one half of the ICRP maximum permissible level in people in non-radiological work (3 μCi). The radiation dose for reindeer herders (men) from ^{137}Cs in 1965 was 140 mrem/y. A few individual Lapp men reached in 1965 the 3 μCi level. Values equal to herders in Lapland were found also in the reindeer herders in Siberia and in the caribou hunters in North America, especially in some Eskimo groups. Two other artificial fallout nuclides, ^{55}Fe and ^{90}Sr, and the natural radionuclides ^{210}Pb and ^{210}Po are enriched by the same foodchain, lichen–reindeer–man. Body burdens of ^{55}Fe and ^{210}Po in Lapps are about 10 times higher, those of ^{90}Sr and ^{210}Pb 3 to 5 times higher than in southern Finland. (auth)

36571 (CONF-670503-18) ENRICHMENT OF RADIOACTIVITY BY ARCTIC ECOSYSTEMS IN FINNISH LAPLAND. Miettinen, J. K. (Helsinki Univ. (Finland). Dept. of Radiochemistry). [1966]. Contract AT(30-1)-3446. 19p. Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

Body burdens of ^{137}Cs were determined for reindeer herding Finnish Lapps and a control group of southern Finns by whole body counting. Iron-55 and ^{210}Po were determined by radiochemical analysis of blood samples. While body burdens of the southern population are of the same order as in the western peoples in general, Lapps contain about 50 times more ^{137}Cs and 10 times more ^{55}Fe and ^{210}Po owing to special ecological factors, mainly the food chains: lichen–reindeer meat–man; and for ^{137}Cs also fresh water fish–man and flooded riverside pastures–cow's milk–man. (auth)

36572 (EUR-3276.e) COMPARATIVE LITERATURE STUDY ON THE PROBLEMS OF THE DECONTAMINATION OF RADIOACTIVELY CONTAMINATED TEXTILES. Reiff, F.; Schuster, K.; Spoor, H.; Stoeppler, M. (Benckiser (Joh. A.) G.m.b.H., Ludwigshafen am Rjeom (West Germany)). 1967. 48p.

Descriptions of the processes used in the decontamination of various (natural or synthetic) textile fibers, as well as simple and complex textile tissues, that were contaminated with radioisotopes or mixtures of radioisotopes are presented. Some of the textile materials considered are cotton, dacron, nylon, orlon, rayon, silk, and wool. The physico-chemical effect of the decontaminating agents, such as chelating agents, complexing agents for certain radioisotopes, detergents, polyphosphates, soap, and water are discussed. Difficulties that can occur during the working up of a waste liquor that contains a decontaminating agent are also presented. The processes or methods used for decontamination are evaluated with regard to application and economy. It was concluded that in the case of the most predominantly used textile fibers, as well as in the case of the most important radioisotopes (^{137}Cs, ^{59}Fe, ^{131}I, ^{226}Ra, ^{90}Sr, and ^{35}S), that very good results could be obtained with the hydroxy-poly-carbonic acid or complexon decontaminating agents. (B.H.S.)

36573 (HASL-32) ELIMINATION OF RADON FROM THE BODY. Harley, John H.; Jetter, Evelyn; Nelson, Norton (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Mar. 20, 1958. 28p. Dep. CFSTI.

Exposure to radon at concentrations that may exist in processing plants results in an appreciable absorption by the body. The absorbed radon is still being expired three days later at a measurable

rate. An exhalation rate which would indicate the presence of a tolerance amount of radium in the body is found 12 hr after exposure. Breath radon measurements are not a valid index of body radium content unless a period of several days is allowed between radon exposure and sampling. A mathematical treatment of the multiphase elimination system is given which fits the experimental data. (auth)

36574 (IITRI-M-6101) CIVIL DEFENSE SHELTER OPTIONS FOR FALLOUT AND BLAST PROTECTION (DUAL-PURPOSE). Final Report. Longinow, A. (IIT Research Inst., Chicago, Ill.). May 1967. Contract OCD-PS-64-50. 240p. CFSTI.

The economic feasibility of incorporating shelters capable of protection against fallout and blast overpressure of 20 to 60 psi into public buildings to be constructed in the future and the upgrading of existing structures to meet the specifications for community shelters is discussed. Types of structures considered include: underground parking garages; subway, railway, and expressway tunnels; and basements of large buildings. Data are summarized on existing community shelters in a number of U. S. locations. Physical and environmental data and cost factors are included for these dual-use personnel shelters. (C.H.)

36575 (JAERI-5015) ACTIVITIES IN THE DIVISION OF HEALTH PHYSICS AND SAFETY, APRIL 1, 1965–MARCH 31, 1966. (Japan Atomic Energy Research Inst., Tokyo). May 1966. 262p. (In Japanese). Dep.

Radiation control activities are reported in the following categories: organization of radiation control group; safety control; reactor and laboratory monitoring; personnel monitoring; environmental control; maintenance of monitors and counting instruments; and radioactive waste treatment and decontamination. Research and development progress is reported on the following topics: radiation measurement; internal exposure; environmental contamination; and contamination and decontamination. A list of publications and oral papers is given in the appendix. (W.E.B.)

36576 (LA-3719) HEALTH PHYSICS SURVEY OF TRINITY SITE. Fey, Frederic L. Jr. (Los Alamos Scientific Lab., N. Mex.). June 16, 1967. Contract W-7405-eng-36. 8p. Dep. CFSTI.

Trinity Site, where the first nuclear weapon was detonated on July 20, 1945, is about 40 miles southwest of Socorro, New Mexico. More than 20 years after the first nuclear weapon test, a health physics survey of the site was made to determine whether it would be radiologically safe for the public to visit. It does not appear that anyone could receive any radiation injury through a visit to Trinity Site. (C.H.)

36577 (NP-16861) PRELIMINARY AERIAL INFRARED FIRE MAPPING SYSTEMS ANALYSIS. Final Report. Sheeder, Richard D.; Duguay, Gretchen L. (HRB-Singer, Inc., State College, Pa.). Apr. 1967. Contract N0022866 CO394. 98p.

A detailed analysis of factors relevant to the infrared thermal mapping of hypothetical nuclear bursts in the State of Michigan was performed. Areas deemed critical to the recovery of the state were determined and designated to be the areas mapped in the event they were struck by a nuclear burst. A survey of civilian aircraft was performed to determine the number and distribution of those possibly available to perform the mapping flight. The total time for the mapping missions was computed for four different thermal mapping system options and for three different levels of mapping resources. An analysis of the numerical data was performed. (49 references) (auth)

36578 (NP-16866) STANDARDS OF PERFORMANCE FOR FILM BADGE SERVICES. Barber, Donald E. (Michigan Univ., Ann Arbor. Dept. of Environmental Health. National Sanitation Foundation, Ann Arbor, Mich.). Sept. 1966. 47p. Public Health Service Free.

Standards of performance for film badge services are of general concern to film badge services, users of these services, and regulatory agencies. A quality control program self-imposed by film badge services, but involving all of these groups, is described. Film badge performance evaluation procedures have been devised to generate data sufficiently broad in scope to serve as the basis for control limits. The evaluation procedures and control limits will be applied in periodic examinations of film badge services. Irradiation procedures, dosimetry, and a measure of film badge accuracy appropriate to the practical use of film badges are discussed. Approximately 2,000 film badges were irradiated with various types and energies of radiation. Exposures ranged from 0.002 to 497 roentgens. Film badge services helped design the test procedures, submitted badges for exposure, interpreted exposures, and assisted in determining provisional performance control limits. All services were informed of the test procedures to be used in the test. However, the services did not know which badges were exposed to what type, energy, or dose of radiation. A measure of accuracy, called an "error factor," was determined for each service for each type and energy of radiation in the test. These error factors are tabulated to show the accuracy of the film badge services tested. Frequency distributions of the error factors served as the basis for selection of control limits used to define acceptable performance. Administrative procedures for periodically evaluating film badge service performance and for recognizing acceptable performance are also described. (auth)

36579 (PPAD-627E) ACTIVATION OF ARGON NEAR A TARGET IRRADIATED BY 3 GeV PROTONS. Awschalom, M.; Larsen, F. L.; Schimmerling, W. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). June 22, 1967. Contract AT(30-1)-2137. 19p. (CONF-670610-5). Dep. CFSTI.

From 12th Annual Meeting of the Health Physics Society, Washington, D. C.

The production of ^{41}Ar, ^{34m}Cl, ^{24}Na, and ^{37}S from ^{40}Ar was measured in the vicinity of an accelerator target bombarded by 3 GeV protons. Also, qualitative evidence was found for the existence of other radioactive nuclides. Health hazards in the vicinity of high intensity, high energy proton accelerators are discussed. (C.H.)

36580 (RRA-M-65) EFFECTS OF NEUTRON ENERGY SPECTRUM IN AIR ON THE NEUTRON INDUCED DOSE IN CONCRETE UNDERGROUND STRUCTURES. Mooney, L. G.; Wells, M. B. (Radiation Research Associates, Inc., Fort Worth, Tex.). Oct. 31, 1966. 33p. (CONF-661001-53). Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

A study was made to determine the effect of two different neutron energy and angular distributions in air on the neutron-induced dose in shielded underground concrete structures. The first neutron distribution used in the calculations corresponded to that expected from a fission neutron source at a distance of 700 meters in air. The second distribution was a much harder spectrum, resulting from the combination of a fission type source and a 14-MeV source. Calculations of the capture gamma-ray and multicollision neutron doses were made at point receivers located three feet above the floor on the geometric centerline of subsurface cubical and parallelpiped concrete structures. The structures were covered with concrete slab shields varying in thickness from 4 to 60 inches. Results of the calculations show relatively little difference in the total neutron-induced dose inside subsurface structures from the source distributions considered in this study. The higher contribution of the neutron dose from the harder source spectrum is offset by the larger capture gamma-ray dose resulting from the more abundant low energy neutrons from the fission-type source. (auth)

36581 (RT/PROT-(66)27) DOSE TO THE THYROID FROM INTAKE OF ^{132}Te. INGESTION OR INHALATION OF TRANSPORTABLE COMPOUNDS. Breuer, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 11p. Dep.

The method used to calculate the thyroid dose owing to ingestion or inhalation of ^{132}Te is reported. Values are obtained for three different metabolic pathways. The data could be used to assess dose to the adult population in the event of a nuclear accident. (auth)

36582 (SFL-A-9) BIOLOGICAL DETECTORS OF RADIOACTIVE CONTAMINATION IN THE BALTIC. Bagge, P.; Salo, Anneli (Institute of Radiation Physics, Helsinki (Finland)). June 1967. 43p. Dep.

Some bottom fauna and pelagic animals are described, which could be used as indicators of radioactive contamination in the Baltic Sea. Some preliminary data on their concentrating rates and factors for ^{137}Cs and ^{85}Sr are given. (70 references.) (auth)

36583 (SZS-3/67) ZUR FESTLEGUNG MAXIMAL ZULAESSIGER KONZENTRATIONEN RADIOAKTIVER SPALTPRODUKTE IN TRINKWASSER FUER DEN KATASTROPHENFALL. (On the Fixing of Maximum Permissible Concentrations by Radioactive Fission Products in Drinking Water for Catastrophic Cases). Strauss, H. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Apr. 1967. 24p. (In German). Dep.

From the great number of radiation protection problems in case of emergency those are discussed that arise when maximum permissible doses and maximum permissible concentrations (MPC) of fallout radionuclides in drinking water are to be determined. A method is indicated that allows derivation of MPC for emergency by extrapolation from the standard MPC. For four different fission product mixtures MPC are calculated and plotted versus decay time. A further graph shows which of the fission nuclides have the greatest influence on the height of the MPC at a given decay time. (auth)

36584 TRAINING IN NUCLEAR (RADIOLOGICAL) TECHNOLOGY AT CHATTANOOGA STATE TECHNICAL INSTITUTE. Scott, W. Wayne; Tippens, Paul E. (Chattanooga State Technical Inst., Tenn.). Trans. Amer. Nucl. Soc., 10: 15-16(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36585 MEASUREMENT OF TRACE ELEMENTS IN TISSUE BY MEANS OF A Ge(Li) DETECTOR WITH COMPTON SUPPRESSION. Cooper, Raymond D. (Massachusetts Inst. of Tech., Cambridge); Linekin, David M.; Brownell, Gordon L. Trans. Amer. Nucl. Soc., 10: 56(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36586 NEUTRON YIELDS FROM MIXTURES OF BERYLLIUM POWDER AND POLONIUM-IMPREGNATED MICROSPHERES. Jordan, E. D.; Carew, T. E. (Catholic Univ. of America, Washington, D. C.). Trans. Amer. Nucl. Soc., 10: 84-5(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36587 EVALUATION OF THE HAZARD RESULTING FROM THE INHALATION OF NEUTRON-ACTIVATED CONCRETE DUST. Smith, R. W. (Northwestern Univ., Evanston, Ill.); Oestmann, M. J.; Cember, H. Trans. Amer. Nucl. Soc., 10: 65-6(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36588 ^{137}Cs–^{60}Co COMPARISON. Rizzo, F. X.; Cunningham, G. E.; Galanter, L.; Cusack, J. H. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 10: 50(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36589 DIFFERENTIAL CALORIMETRIC METHOD FOR MEASURING ABSOLUTE ENERGY DOSES ABSORBED BY SUBSTANCES IN A MIXED REACTOR FIELD. Khristov, V.; Apostolov, T. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci., 19: 1001-4(1966). (In Russian).

Mixed doses due to gamma rays and fast neutrons can be determined by using two copper-constantan thermocouples placed in cylindrical jackets of graphite and polyethylene. The graphite-encased thermocouple is sensitive to gamma rays, and the polyethylene-encased thermocouple is sensitive to the fast neutrons. The total dose is determined from the rate of temperature rise and the heat capacity of the substance. The differential gamma and fast neutron dose can be determined to an accuracy of 10 to 15% from the calorimetric readings by solving two simultaneous equations. A tissue sample showed a dose of 9.84×10^6 rads/hr due to gamma radiation and a dose of 7.21×10^6 rads/hr due to fast neutron radiation, when exposed in the center of a vertical channel of the IRT reactor in Sofia. The thermal neutron contribution could be estimated by the use of activation analysis of cadmium-wrapped samples. (TTT)

36590 RADIOACTIVE CONTAMINATION OF HIGH ALTITUDE AIRCRAFT AND AIR-INDIA MONITORING PROGRAME. Yelahanka, K. N. M. (Air-India, Bombay). J. Aeronaut. Soc. India, 18: 84-9(Aug. 1966).

An account is given of a radioactive contamination survey on Boeing 707 aircraft and the procedure adopted for decontamination and ensuring health safety. The experience indicates that aircraft flying wholly within the troposphere do not become significantly contaminated and the inside of the aircraft cabin is safe even after the aircraft has flown through a radioactive cloud. The radioactive debris collected on an airplane flying in the contaminated atmosphere is classified under 3 categories: the loose contamination of the superficial type removed just by wiping; the removable type, requiring extra effort and even use of chemical agents and detergents; and the fixed type, which due to chemical or physical action remains bound to the aircraft parts. The loose and removable type of contamination is usually associated with the airframe. The monitoring survey included the measurement of β and γ activity by swipe sampling. From the results of continued survey it was observed that on the airframe, the painted surfaces, engine pods, and cabin air intake areas showed significant activity levels. In the case of Conway Engines, highest activity levels were recorded on the LP-1 turbine shaft. On IGV housing and exhaust components the activity levels were slightly above background. On other parts, surface activity was well below the permissible occupational exposure dose. Although the aircraft did fly through hot areas in some flight sectors and had accumulated sizable activity levels on some occasions, it was found that the levels inside the passenger cabin and crew area were negligible. The ordinary cleaning and washing procedures used on the aircraft and the specialized cleaning and degreasing process used on engine components were found to be adequate for decontamination. (BBB)

36591 RADIATION HAZARDS AND PUBLIC HEALTH. Meckstroth, George R. (Tulane Univ., New Orleans); Parker, Roy A. J. La. State Med. Soc., 119: 121-6(Mar. 1967).

Recommendations of the Louisiana Division of Radiation Control for protection of patients during dental and diagnostic radiography are reviewed. (C.H.)

36592 RADIOACTIVE FOOD CHAINS IN SUBARCTIC REGIONS. Miettinen, Jorma K. (Univ. of Helsinki). Naringsforskning, No. 4, 97-106(1965). (In Dutch).

The origin and distribution of global fallout are reviewed and three unique foodchains of cesium-137 and strontium-90 prevailing in the subarctic regions are described. The most efficient of these chains leads from lichen to reindeer meat, another from wild pastures (flooded river banks growing sedges and horsetails) to cow's meat and milk, the third one exists in the extremely pure waters of the Lapland lakes leading from plankton through small fish to predatory fish. Thus, all three chains end in important constituents of man's diet, which in Lapland contains 10 to 60 times more ^{137}Cs than in southern Finland. They are consumed in large quantities by the local population, which has on the average 10 to 40 times higher body burdens of cesium-137 than the average for the northern hemisphere population. The highest body burdens are found in reindeer-herding Lapps (in winter 1965, average 1, maximum 3 μCi in males). This is owing to their high consumption of reindeer meat (average 0.5 kg/day in winter). Seasonal variations in the diet and body burdens are great. The diet of the Lapps, its radiocesium content, the role of the different foods in the intake of cesium-137, and the body burden of this nuclide in the Lapp population have been intensively studied since 1961. The results of these investigations are reviewed in some detail and the situation regarding strontium-90, and the natural alpha-nuclide, polonium-210, is briefly summarized. (auth)

36593 RAPID SEPARATION OF ^{91}Y IN FALL-OUT BY LIQUID–LIQUID EXTRACTION WITH DI-(2-ETHYLHEXYL) ORTHOPHOSPHORIC ACID (HDEHP). Testa, Corradio; Papucci, Carlo (CNEN-CSN, Casaccia, Italy). G. Fis. Sanit. Prot. Radiaz., 10: 188-92(July-Sept. 1966). (In Italian). (RT/PROT-(67)8).

A new radiochemical method for the rapid isolation of ^{91}Y from fission products present in fallout is described. After dissolution of the dried residue (1 to 5 grams) in 6 M HCl, the acid is diluted to 0.3 M. Yttrium is then quantitatively separated from the other radionuclides (except ^{95}Zr–^{95}Nb) by liquid–liquid extraction with di-(2-ethylhexyl) orthophosphoric acid (HDEHP) 20% in xylene; a complete separation from the rare earths (Ce, Pr, Nd, Pm) is then obtained by washing with 0.3 M HCl. Yttrium is precipitated as $Y(OH)_3$ and beta decay is followed to determine ^{91}Y activity. The result of the half-life measurement confirmed the good decontamination from other beta-emitting radionuclides; furthermore, the separation from gamma-emitting radionuclides was demonstrated by prolonged gamma spectra. Yttrium recovery resulted 92.8 ± 2.5%. The analysis can be carried out in three hours. The method is sufficiently rapid, selective and accurate to determine yttrium (^{90}Y,^{91}Y) in whatever fission product mixtures. (auth)

36594 SKIN DOSAGES IN RADIATION-SPARING TECHNIQUES FOR THE LABORATORY AND FIELD. Garn, Stanley M.; Helmrich, Ralph H.; Flaherty, Kathleen M.; Silverman, Frederic N. (Fels Research Inst., Yellow Springs, Ohio). Amer. J. Phys. Anthropol., 26: 101-5(Jan. 1967).

Problems relating to radiation exposure of the subjects in the use of radiographic techniques in anthropological research are discussed. The magnitude of skin doses has become both a practical and an ethical problem. Funding agencies in the United States now require prior information on the levels of radiation involved, and health officials in many countries may demand such information before approving population studies. Skin doses are reported for various extremity and soft-tissue radiographs which yield very low gonadal doses (under 1 mR) and maximum information on ossification status, cortical bone thickness and growth, and loss of tissue components. Both screen-type and nonscreen film techniques and various types of radiographic equipment, including a new, extremely lightweight and portable unit particularly suited to field use, were used. Skin doses of penetrating radiation were based on charged-electroscope dosimeter readings from representative extremity, chest and soft-tissue techniques employing radiation-sparing approaches to minimize direct (skin) radiation. The measured skin doses were 2 to 17 mR for screen-type techniques and up to 43 mR for nonscreen techniques, and may be compared with background dosages of 100 mR/yr at sea level to ~300 mR/yr at an altitude of one mile. Accordingly, it is con-

cluded that doses from screen-type extremity views total from under 1% of the irreducible minimum background level to under 20%. In contrast, non-screen techniques yield skin doses up to 43% of the yearly background dose, depending on technique and altitude. (BBB)

36595 RESEARCHES ON THE RADIOACTIVE CONTAMINATION PRODUCED BY THE CHINESE NUCLEAR EXPLOSIONS 16TH OCTOBER 1964–14th MAY 1965. Giorcelli, Franco G.; Cigna, Arrigo A. (CNEN, Rome). G. Fis. Sanit. Prot. Radiaz., 10: 192-9(July-Sept. 1966). (In Italian). (RT/PROT-(67)1).

Results of measurements made on environmental radioactivity during the period following the explosion of the first Chinese bomb are presented. The possibility of promptly detecting the presence of recent fission products in the air even with very low levels of contamination is discussed. The nature of the explosive is considered. Results confirmed that the explosive was ^{235}U. (auth)

36596 EFFECTIVENESS OF DTPA ADMINISTRATION ON INTRODUCTION OF RADIOACTIVE ISOTOPES OF BARIUM AND LANTHANUM INTO THE ORGANISM. Efimov, V. I. (Inst. of Biophysics, Moscow). Radiobiologiya, 7: 90-2(1967). (In Russian).

A solution of $^{140}BaCl_2$ in equilibrium with ^{140}La was injected intraperitoneally into rats in a quantity of 0.73 μCi/g. The rats then received repeated injections of a 10% solution of the Na_3Ca salt of diethylene triaminopentaacetic acid (DTPA) up to the 22nd day after introduction of the radioactive isotopes. DTPA increased significantly the excretion of ^{140}La in the urine (92.57 vs 2.0% for controls within the first two days), but had a relatively slight effect on the excretion of ^{140}Ba (8.57 vs 1.62% for controls within the first two days). The half-time for excretion of the isotope mixture was 24 hr after administration of DTPA to the rats. DTPA did not reduce the resorption of ^{140}Ba by the skeleton. However, its administration of incorporation of ^{140}Ba must be regarded as advantageous because of the elimination of ^{140}La formed by the decay of ^{140}Ba. Notwithstanding its short half-life, ^{140}La is capable of causing considerable injury to the organism by reason of the high-energy γ emitted during its decay. (JPRS)

36597 SPATIAL DISTRIBUTION OF ABSORBED DOSES OF X RAYS OF VARYING HARDNESS IN A TISSUE-EQUIVALENT DOG PHANTOM. Savchenko, N. Ya.; Sokolova, I. K.; Keirim-Markus, I. B. (Inst. of Medico-Biological Problems, Moscow). Radiobiologiya, 7: 13-15(1967). (In Russian).

Dosimetric measurements of x ray absorption were carried out by irradiation of a heterogeneous dog phantom consisting of a dog skeleton and a tissue-equivalent mixture of 81% paraffin wax + 19% SiO_2 and of a homogeneous phantom formed by a plaster of Paris cast of a dog's body. With 180 kV x rays, the difference between the average tissue doses for the homogeneous and heterogeneous phantom did not exceed 10%. At 80 kV, this difference approached 30%. (JPRS)

36598 SEASONAL AND AGE VARIATION IN THE SKELETAL RADIOACTIVITY OF MICROTUS AGRESTIS L. FOLLOWING INCORPORATION OF ^{90}Sr UNDER NATURAL CONDITIONS. Il'enko, A. I.; Romanov, G. N. (Inst. of Biological Physics, Moscow). Radiobiologiya, 7: 76-8(1967). (In Russian).

Dark voles (Microtus agrestis L.) were kept under natural conditions in an enclosure with an area of 1 hectare which had been artificially contaminated with ^{90}Sr in an amount of 1.8 to 3.4 mCi mCi/m^2. The accumulation of $^{90}Sr + ^{90}Y$ in the skeleton was determined periodically by cutting off a part of the tail of the animals and measuring the radioactivity in the bone. The voles born in the beginning and middle of the summer accumulated the radioactive isotopes in the skeleton towards the second half of the winter in a higher concentration than those born at the end of the summer, so that their rate of survival in the winter was lower (6.6 vs 55.8%). The voles that were born late in the season and survived the winter were apparently hardened by the combined effects of adverse weather and radiation injury, with the result that they survived larger doses of resorbed radioisotopes in the following summer than those animals that were born early in the season and exposed in the preceding summer. (JPRS)

36599 ON A CASE OF INTERNAL CONTAMINATION BY ^{170}Tm. Strambi, E.; Testa, C. (CNEN, Rome. Univ., Rome). G. Fis. Sanit. Prot. Radiaz., 10: 199-202(July-Sept. 1966). (In Italian). (RT/PROT-(67)4).

Measures taken after a case of internal contamination with thulium-170 are described. Beta and gamma countings on nasal swabs, urine, and feces samples were carried out. Nasal swabs were of particular interest to detect the amount of contamination, and fecal analyses were necessary to evaluate the intake. From the fecal excretion curve, it was determined that the ^{170}Tm inhaled quantity resulted in much less than the maximum permissible body burden. (auth)

36600 CONCEPT OF HEALTH PHYSICS DOSIMETRY FOR QUANTUM RADIATION. Piesch, E. (Karlsruhe Nuclear Research Center, Ger.). Health Phys., 13: 759-66(July 1967).

The concept of dosimetry for external quantum radiation, as developed in this paper, starts from the basic assumption that the dose reading of personnel dosimeters and area dosimeters shall indicate the radiation hazard to a person to the same extent and that it is a requirement for measuring techniques in Health Physics monitoring to assess the quantity absorbed dose instead of the quantity exposure. Phantom measurements show to what extent the reading of personnel dosimeters deviates from the free-space determined area dose. The possibilities of realizing absorbed dose measurements in free space, and in conjunction with a phantom, are discussed. The new concept of dosimetry is characterized by absorbed dose quantity measurement and by different calibration of area dosimeters (free-space irradiation) and personnel dosimeters (phantom irradiation). Dosimeter systems are described which realize agreement between readings of area dosimeters and personnel dosimeters, and therefore provide a reasonable interpretation of personnel dosimeter readings. (auth) (UK)

36601 A METHOD OF CALCULATING INTRACRANIAL THERMAL NEUTRON ISODOSE CURVES. Robertson, J. S. (Brookhaven National Lab., Upton, N. Y.); Levine, D. A.; Farr, L. E. Contracts AT(302)-GEN-16; AT(40-1)-3084. Meth. Inform. Med., 6: 79-83(Apr. 1967). (BNL-11113).

A method is described for obtaining by numerical integration a modified geometry factor that takes into account buildup and nonuniform source distribution patterns for use in calculating radiation doses for thermal neutrons. This analysis was applicable particularly for neutron capture therapy in the treatment of brain tumors, the intracranial contents being regarded as being subjected to the following three sources of radiation: protons and γ rays from reactions between thermal neutrons and normal tissue constituents; heavy particles and rays from reactions between thermal neutrons and the neutron capture nuclide introduced; and fast neutrons and γ-ray contaminants of the incident neutron beam. The calculations involved in estimating the radiation dose at a given point are similar for the first and second of the above radiation sources, and these are considered especially. A table lists values for the physical factors required in the dose calculations. An illustration is given of a neutron flux pattern obtained experimentally, using the thermal neutron beam at the treatment port of the Brookhaven National Lab. Medical Research Reactor. The measurements were made by inserting gold wires into a tissue-equivalent phantom and determining the nvt from the activity induced in segments of the wires. This method was also applied to animals and to patients treated by neutron capture therapy. The isoflux curves shown were approximated by assuming a point source of neutrons in a distance 3.5 cm from the proximal end of the cylinder and fitting the axial flux with a formula. The resulting isodose curves are shown. (BBB)

36602 THE ^{90}Sr ACTIVITY OF MILK IN 1965. Seidler, H.; Haertig, M. (Institut fuer Ernaehrung, Potsdam-Rehbruecke, Ger.). Nahrung, 10: 359-61(1966). (In German).

The maximum activity of ^{90}Sr detected in milk collected from the Potsdam area in 1965 differed from month to month primarily as a result of the fodder used. The maximum value occurred in the late winter–spring season when the oldest hay that contained the ^{90}Sr from the previous early summer was fed to cattle. Thus the ^{90}Sr of the milk from these animals would be affected by this fodder. The annual mean for 1965 milk was ~8 Sr units, which was ~25% less than in 1964. The values obtained agreed well with other observations from central Europe. In comparison with other parts of Germany the absolute value of contamination in milk found in this area is relatively small. (BBB)

36603 CONTENT OF ^{90}Sr IN LEAVES AND FRUITS OF SOME FRUIT TREES. Kavteladze, B. M.; Datukishvili, N. M. (Inst. of Botany, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 46: 195-7(Apr. 1967). (In Russian).

The content and distribution of atmospheric deposits of ^{90}Sr in various organs were studied in fruit trees in Georgian SSR. The results of the investigations in 1964, using the leaves and fruits, showed that a comparably high content of Sr was found in Bere Bock pear, Napoleon cherry, and Kevadze peach trees. In other cases the content of ^{90}Sr was negligible and did not exceed 0.25×10^{-10} Ci/kg. The leaves of the trees investigated contained more ^{90}Sr than the fruit, and the ^{90}Sr taken up by the roots was negligible in the fruit. (R.V.J.)

36604 EVALUATION AND REGISTRATION OF IRRADIATION DOSES OF NUCLEAR WORKERS. Breuer, F.; Strambi, E. (CNEN, Rome). G. Fis. Sanit. Prot. Radiaz., 10: 165-70(Apr.-June 1966). (In Italian). (RT/PROT-(67)9).

A form suitable for the medical surveillance of radiation re-

ceived by nuclear workers is presented. The form, that is a needle punch-card, covers a 5-year period and reports quarterly the principal data concerning external and internal irradiation as well as body burdens of radioisotopes. The differences between this form and similar health physics documents are based on its synthetic nature and on the inclusion of typical medical data. (auth)

36605 IDENTIFICATION AND RADIOCHEMICAL SEPARATION OF THE ^{106}Ru RADIONUCLIDE IN CERTAIN ALGAES OF THE BLACK SEA, RUMANIAN COAST. Georgescu, Iulia I. (Institut Polytechnique, Bucharest); Cojocaru, V. Rev. Roum. Phys., 12: 171-6(1967). (In French).

Ruthenium-106 and rhodium-106 were isolated by radiochemical methods from ashes of some algae collected in June 1965 in the Black Sea along the Rumanian coast. The ^{106}Ru was identified by absorption in Al of the β radiations emitted by ^{106}Rh and by the analysis of the γ spectrum using a pulse analyzer with 400 channels and a NaI(Tl) crystal. The activities of ^{106}Ru–^{106}Rh have the following values: 2.8 ± 0.7 pCi/g ash of Cystoseira barbata and 1.6 ± 0.4 pCi/g ash of Laurencia coronopus. (tr-auth)

36606 A METHOD FOR THE STUDY OF SPATIAL DISTRIBUTION OF TISSUE DOSES IN X-RAY AND GAMMA-RADIATION FIELDS. Avetisov, G. M. Radiobiol.-Radiother., 8: No. 1, 61-6(1967). (In German).

A homogeneous phantom for the study of the spatial distribution of the absorbed dose in the body of the rat in x-ray and γ-radiation fields is described. The ferrosulfate dosimeter system was used. A method for calculating the mean tissue-dose rate and the integral absorbed dose in the whole body of the rat and in any part considering the heterogeneity of the animal body is recommended. (auth)

36607 DOSE DETERMINATION IN THE RECTUM AND URINARY BLADDER FOR GYNECOLOGICAL RADIUM IMPLANTATIONS. Caha, A.; Kotas, J. (Onkologische Institut, Brno). Radiobiol.-Radiother., 8: No. 1, 51-9(1967). (In German).

For different radium implantations and their combinations, more than 3000 measurements in the urinary bladder and rectum were performed by means of a scintillation device in 150 gynecological carcinomas. For single patients comparative measurements were done at the gynecological chair and in the bed in normal position. The results of the measurement showed differences that may be explained by the changed intraabdominal pressure due to the different position of organs during the measurements. The changed position of the urethra, uninary bladder, rectum, and sigmoid with respect to the radium implantation was represented by roentgenography and cystography. (auth)

36608 CHANGE IN THE ^{137}Cs CONCENTRATION IN HUMANS. Sivintsev, Yu. V.; Kanareikin, V. A.; Arutinov, O. M. (Inst. of Atomic Energy, Moscow). Radiobiologiya, 6: 822-5(1966). (In Russian).

Monthly measurements of a control group of 10 adult men who had no occupational contact with radioactive substances, using a spectrometer designed by the authors, were conducted to determine the point of inflection on the curve of the variation of the specific activity of ^{137}Cs in the human organism, resulting from the cessation of atmospheric nuclear testing. The results obtained are compared with analogous investigations conducted in Sweden and the United States. It was found that the concentration of long-lived ^{137}Cs in the human organism began to drop in the middle of 1964. Indirect support for the importance of milk in the diet as a source of ^{137}Cs was obtained in observations of a subject who consumed about 1.5 liters of milk per day, approximately three times the average level. Bread and groats are also presumed to be important sources of uptake of this isotope. (JPRS)

36609 EVALUATION OF ^{90}Sr + ^{90}Y SURFACE CONTAMINATION USING RADIATION SURVEY INSTRUMENTS. Dummer, Jerome E. Jr. (Los Alamos Scientific Lab., N. Mex.). pp 185-95 of Surface Contamination. New York, Pergamon Press, 1966. (LA-DC-4467).

Work is described that shows: a relation between measurements with a gamma radiation survey meter and the quantity of beta emitter deposited on surfaces; and a relation between true surface dose rate and the indicated contact dose rate as measured with survey type instruments for a beta-emitting isotope. This information is useful in determining the hazard due to a spill of radioactive material and the extent of decontamination required. (W.E.B.)

36610 THE PATHOLOGY OF IONIZING RADIATION. PREVENTIVE ASPECTS. Coppola, A. Folia Med. (Naples), 49: 261-74(Apr. 1966). (In Italian).

After briefly reviewing the lesions that may result from exposure to ionizing radiation, the need for thorough hematological examinations, in particular hemochromometric and coagulation tests using appropriate methods, with the aim of obtaining a precise diagnosis and ordering the immediate removal from exposure of occupationally exposed persons with an unsatisfactory blood picture is discussed. Other fundamental aspects of health protection in this field, namely, technical radiation dose monitoring methods and chemical and biological protection from the effects of radiation are also considered. (auth) (Occup. Safety and Health Abstr.)

36611 ENVIRONMENTAL HEALTH AND SAFETY AT HARVARD. Ferris, Benjamin G. Jr. (Harvard School of Public Health, Boston). Harvard Public Health Alumni Bull., 23: 6-9 (July 1966).

Radiation protection services at Harvard University are described as well as some problems of monitoring. The radiation protection service routinely surveys 120 laboratories for radioactive contamination and reviews isotope handling, and waste disposal procedures. Over 1400 persons are provided with film badges which are processed at least monthly to determine whether any significant radiation exposures have been accumulated. Formal short training programs are given in the safe use of radioisotopes for all technicians engaged in radioisotope work, and more intensive study programs on radiation protection methods are required for all investigators who supervise the use of radioisotopes. Routine surveys have uncovered unexpected and unusual radiation situations. An investigation of a building that had been used for studies of U during the era of the Atom Bomb Project, uncovered the storage of large amounts of U. A thorough survey of the radioactivity in the environment resulted in relocation of U samples to eliminate any unnecessary radiation exposure to personnel. Surveys in old chemical laboratories revealed instances of Ra contamination. The personnel film badges worn by radioisotope workers sometimes showed radiation exposures indicative of poor working habits rather than of accidental exposures. In one instance it was found that the film badge wearer had been distilling ^{131}I in a column directly in front of himself without shielding. When shielding was installed, exposure of the worker dropped to acceptable levels. In another instance the ashes from an incinerator, during regular monitoring for possible radioactive contamination, were found to be contaminated. A sample was analyzed, and from the type and energy of the emissions it was possible to identify the isotope as well as its source. Monitoring of the environment around various sources of high energy radiation, such as the cyclotron and the accelerator, is also mentioned. (BBB)

36612 HEALTH PROTECTION IN THE NUCLEAR ENERGY INDUSTRY. Tepper, Lloyd B. (Univ. of Cincinnati). Harvard Public Health Alumni Bull., 23: 10-13(July 1966).

Various aspects of surveillance of radiation hazards in nuclear installations are reviewed. Of all the potentially hazardous environmental factors that have been most intensively and systematically studied, radiation is foremost. Responsibility of health physics extends from radiation monitoring of personnel, plants, and environment to the design of shielding and participation in selecting suitable sites for reactors, fuel-processing plants, or waste disposal areas. In spite of high levels of radioactivity associated with industrial operations, overexposure is unusual and detectable radiation injury has been extremely rare. Occupational hazards due to F, Be, and Hg in the nuclear energy industry are also considered. Disposal of large amounts of highly radioactive solid and liquid industrial wastes is discussed. As storage becomes an increasingly unsatisfactory means for the disposal of high-level liquid wastes, other procedures are being examined, including various methods of concentration and solidification into concrete, ceramics, or glasses and direct disposal of liquid concentrates in natural salt domes or special excavations in shale formations. (BBB)

36613 EFFECT OF CONSTRUCTION AND PRODUCTION PROCESS ON THE EFFECTIVENESS OF SCATTERED RADIATION SCREENS. Schubert, Wolfgang (Siemens-Reiniger-Werke AG, Erlangen, Ger.). Roentgenpraxis, 18: 277-88(Dec. 1965). (In German).

Improvements in scattered radiation screens may reduce radiation hazards during their use in x ray diagnosis. The author describes the construction and manner of operation of the scattered radiation screens, and demonstrates that the ratio of the perforation height to width, or perforation ratio is not an appropriate computed number that is suitable for evaluation of the raster efficiency, because it does not take the technological differences of the raster into account. A practical basis for the evaluation and comparisons of rasters only can be a measured magnitude. According to the recommendations of the International Commission on Radiological Units and Measurements, this is defined and measured as the selectivity. There is a geometric relation between the perforation ratio, format width, and limits of use which will permit calculation of the range of use of a raster. By means of comparisons of photographs made with a given raster screen and certain criteria of selectivity, the author demonstrates

that at present it is possible to produce a 40-line raster with high efficiency. The author presents numerous data to demonstrate relations between parameters that affect efficiencies, selectivities, and contrast improvement. (BBB)

36614 CESIUM AND RUBIDIUM IN SEA WATER. Riley, J. P.; Tongudai, M. (Univ. of Liverpool). Chem. Geol., 1: 291-4(Dec. 1966).

A cation exchange scheme was developed for the separation of Cs and Rb from sea water prior to their spectrographic determination. To determine the optimum conditions for separation of the rare alkali metals, experiments were carried out in which 11 aliquots of sea water spiked with ^{86}Rb and ^{137}Cs were passed through columns of the cation exchanger ZeoKarb 225 (52-100 mesh) in its H form (2.5 cm dia, 62 cm long). It was found that practically all the Na and some K could be eluted from the column with 1.31 of 0.5N HCl without eluting any Rb and Cs. It was not possible to elute the latter elements separately, but substitution of a sulfonated phenol-formaldehyde resin (ZeoKarb 215) for the sulfonated polystyrene resin gave a satisfactory resolution of Rb from Cs. Examination of filtered surface samples of water from the Irish Sea collected monthly showed the presence of 119 ± 4 μg/Rb/1 and 0.55 ± 0.06 μg/Cs/1 (normalized to salinity 35°/00). Analyses of composite samples collected in various depth ranges from the North Atlantic gave similar results. (BBB)

36615 ENVIRONMENTAL CONTAMINATION WITH RADIO-RUTHENIUM 1961 TO 1965. Iwashita, Kiyoshi; Yamagata, Noboru (Inst. of Public Health, Tokyo). J. Radiat. Res., 7: No. 2, 91-111(June 1966).

The results of measurements of ^{103}Ru and ^{106}Ru in airborne particles, fallout, surface soil, river water, sea water, foodstuffs, complete diet, and human muscle and lungs during 1961 to 1965 are summarized. Main passage route of ^{103}Ru was found through the fresh leafy vegetables, while ^{106}Ru was supplied by different way, i.e., 77% by plant materials raised on land, 6% by foodstuffs of animal origin and the remainder by seaweed; the concentration was the highest in the last item. Estimation of lung and body burdens was performed on the basis of observed data for inhalation and ingestion and compared with the result of measurements on human materials obtained from cadavers. The mobility of fallout ruthenium in the sequence between precipitation and run-off from rivers seemed a little larger than strontium and much larger than cesium, reaching 14% of fresh fallout to be delivered to the sea. Average concentration factor from sea water to seafood as a whole was found to be 70 or equivalent daily intake of seawater to be 7 kg. On this basis, the maximum permissible concentration of ^{106}Ru in sea water was suggested as 3×10^{-6} μCi/ml. (auth) (NSA of Japan)

36616 RADIOACTIVE CORPSES. Brit. Med. J., 1: 331 (May 6, 1967).

Hazards associated with handling cadavers bearing radioisotopes, administered clinically, are considered, particularly with reference to a recent report pertinent to this problem issued by the Australian National Health and Medical Research Council. When a patient dies in hospital, a radioisotope given therapeutically to a patient a few days before death may be forgotten, so that there is a potentially serious risk to the post-mortem room attendant, pathologist, or embalmer. Radioisotopes are not usually given to moribund patients, but occasionally a patient who has been treated with intraperitoneal ^{198}Au for metastatic tumor, or one who has had a high dose of ^{131}I for thyroid carcinoma, may die unexpectedly within a few days of treatment. The Australian report sets out a code of practice for the safe handling of corpses containing radioactive substances, and deals concisely and clearly with the main problems. In many instances it is possible to reduce the level of radiation greatly by removing part or all of the main source of radioactivity at the start of the necropsy or before embalming. The ascitic fluid can be removed by suction pump, and the thyroid and major metastatic deposits can be resected and stored until the level of radioactivity has fallen to a safe level. The problem of whose responsibility it is to warn the pathologist or mortuary attendant that a therapeutic dose of radioisotope has recently been administered is discussed. (BBB)

36617 STUDIES ON THE PRESENCE OF Sr IN MARINE PLANKTON IN RELATION TO THE ECOLOGY OF ACANTHARIA. Schreiber, Bruno; Bottazzi-Massera, Elsa; Fano-Schreiber, Ada; Guerra, Franca; Pelati, Laura (Univ., Parma). Pubbl. Sta. Zool. Napoli, 32: Suppl., 400-26(1962). (In Italian).

The possibility is suggested that Acantharia, because of their selective accumulation of Sr, may be involved in the problems concerning the fixation and circulation of radioisotopes in marine waters. The chemical composition and mineralogical structure of the spicules of Acantharia were studied by radiographic analyses with the Weissenberg method. The spicules were shown to be monocrystals of celestite. A correlation between the total Sr content of plankton and the presence of Acantharia was demonstrated and factors possibly affecting the correlation were examined. A report of the species found in the Mediterranean Sea and their relative frequency is given, and episodes of proliferation, that is, an absolute prevalence of a single species, are described. The different situations presented by Tyrrhenian and high Adriatic Seas in relation to the distribution and prevalence of Acantharia are pointed out; possible causes are suggested and discussed in relation to the Sr levels of plankton in these bodies of water. (BBB)

36618 RADIOECOLOGICAL CONCENTRATION PROCESSES. Proceedings of an International Symposium held in Stockholm 25–29 April, 1966. Aberg, Bertil; Hungate, Frank P. (eds.). New York, Pergamon Press, 1967. 1051p. (CONF-660405).

One-hundred and one papers discuss the radioecological concentration processes that affect the distribution of fallout radioisotopes and their movement through the biosphere to man. Emphasis is placed on the transport of ^{137}Cs, ^{131}I, ^{85}Sr, and ^{90}Sr through soils, plants, animals, foods, and man. A useful index of nuclides of interest is included. (1518 references.) (C.H.)

36619 CLEANSING AGENTS FOR PURIFYING SURFACES CONTAMINATED BY RADIOACTIVE MATERIALS. (to United Kingdom Atomic Energy Authority). French Patent 1,303,673. Aug. 6, 1962. Priority date Aug. 16, 1960, Great Britain.

Particulate or fluid radioactive material can be removed from a surface by applying a liquid agent, containing a filmforming material (preferably natural India-rubber latex) and a detergent, and subsequently stripping the formed flexible film from the surface. Several compositions are given. (auth)

36620 PROCESS AND APPARATUS FOR THE DECONTAMINATION OF OBJECTS AND SURFACES, CONTAMINATED BY RADIOACTIVE SUBSTANCES. (to VEB Konstruktion und Projektierung Kerntechnischer Anlagen). French Patent 1,293,540. Apr. 9, 1962. Filed Jan. 4, 1961.

Steel surfaces are decontaminated by electrolytic polishing, using an auxiliary electrode that can be tightly pressed against the surface to be treated. The chamber thus formed between said electrode and the surface is first evacuated and then filled with a flowing electrolyte. (auth)

36621 COMPOSITION FOR THE DECONTAMINATION OF SURFACES SUBJECTED TO NOXIOUS RADIATIONS. Godat, M. French Patent 1,298,977. June 12, 1962. Filed June 5, 1961.

A number of lotions and pomades which contain as the active constituents 500 to 1500 ppM of a $C_{10}H_{16}$ terpene (e.g., citral, pinene, terebene) and a detergent were developed for use in the decontamination of surfaces of radioactivity. These compositions are applied on the surfaces which have been exposed to dangerous radiations. The radiation causes resinification of said compositions; the resinified products can easily be eliminated from the surface together with adhering contaminants. If applied on the human skin the compositions contain an ozonide as a process starter. (auth)

36622 PRODUCTS FOR DECONTAMINATION OF PERSONS, OBJECTS, AND PLACES AFFECTED BY RADIOACTIVE SUBSTANCES AND DUSTS. Florent, R. G. French Patent 1,280,139. Nov. 20, 1961. Filed Nov. 28, 1960.

The use of water or oil soluble oxyethylenated fatty acids and/or complex amino acids as decontaminating agents for skin is described. The agents can be used in aerosol dispensers, as shampoos, or in the form of drops or baths for treatment of the eye, the nose, the ear, or the mouth. (auth)

Medicine

Refer also to abstract 36497.

36623 (JPRS-41149, pp 65-73) NEW APPROACHES TO DIAGNOSIS OF THROMBOSIS AND ATHEROSCLEROSIS USING RADIOACTIVE LYTIC AGENTS AND COAGULANTS. Bogolyubov, V. M. Translated from Vestn. Akad. Med. Nauk SSSR, 22: No. 4, (Apr. 1967).

Use of iodine-131-labeled agents for detection of atherosclerosis and thrombi is discussed. Among the agents considered were the following: fibrinolysin (plasmin) streptokinase, and fibrinogen. Experimental results are given from work with dogs and rabbits. It was concluded that lytic and coagulant agents labeled with iodine-131 can be used to detect thrombi in paired organs where comparative radioactivity counts can be determined. In atherosclerosis, application appears limited to detection of the amount of fibrins deposited in the otherosclerotic vessels. (W.E.B.)

36624 EFFECT OF PHARMACOLOGICAL AGENTS ON THE ELIMINATION OF ^{198}Au. Petkov, V.; Kushev, V. Eksp. Med. Morfol., 5: 160-5(1966). (In Bulgarian).

The effects of EDTA, dithiopropanol, sodium ethylxanthogenate, hydrochlorothiazide (a saluretic for peroral adminstration), and the sodium salt of dehydrocholic acid (decholin) on the elimination of ^{198}Au were studied in mice in which this radioisotope was injected intraperitoneally. The decrease in the total γ-activity caused by injection of ^{198}Au was measured. It was established that EDTA, dithiopropanol, and decholin increased the elimination of the radioisotope, while hydrochlorothiazide and sodium ethylxanthogenate had no effect. It was found in experiments on rats that EDTA and dithiopropanol promoted accumulation of ^{198}Au in the spleen, hydrochlorothiazide accelerated accumulation of ^{198}Au in the liver, and EDTA lowered the content of ^{198}Au in the kidneys. It was established in former work that the effect of garlic in facilitating elimination of ^{198}Au was also associated with increased accumulation of this radioisotope in the spleen. The results indicated that the effect of substances in eliminating radioisotopes may be rendered valueless by selective accumulation of the radioisotopes in some organs under the influence of these substances. (JPRS)

36625 RESULTS OF TREATMENT OF VAGINAL CARCINOMA FROM 1955 TO 1959 AND PRELIMINARY RESULTS OF TELECOBALT MOVING-BEAM IRRADIATION FROM 1960 TO 1964. Mau, S. (Univ., Berlin). Radiobiol.-Radiother., 7: 729-32(1966). (In German).

The results of treatment with conventional therapeutic measures in primary vaginal carcinoma from 1955 to 1959 are compared with those with telecobalt moving-beam irradiation from 1960 to 1964. From the 19 patients of the first group there results a 5-years survival quota of 21.1 percent that is not essentially exceeded by the presumable 5-year survival quota of the 23 patients of the second group with 24 percent. (auth)

36626 CLINICAL APPLICATION OF ^{113}Sn–^{113m}In COW (SECOND REPORT). Hisada, Kin-ichi; Mishima, Tsutomu (Kanazawa Univ., Japan). Radioisotopes (Tokyo), 16: 377-82(Aug. 1967). (In Japanese).

The preparations of ^{113m}In compounds and their clinical use for scanning of organs such as the heart and placental blood pool, brain, and spinal subarachnoid space as well as inhalation scanning are described. A new compound ($^{113m}In_2S_3$) was synthesized successfully for liver and bone marrow scanning. This $^{113m}In_2S_3$ colloidal solution did not contain any amount of ^{115}In as carrier. In addition, liver uptake of this colloid was very high (average 84.4% in four rats) and terminal sterilization by millipore filter was possible. Such short-lived nuclides as ^{113m}In (half-life 1.7 hrs.) must be prepared quickly to make use of their characteristics as the scanning agents. ^{113m}In-labeled compounds, except for lung scanning agent, may be sterilized by 0.45μ millipore filter and the time required for all process is very short (almost within ten minutes). (auth)

36627 RESULTS OF ^{60}Co TELETHERAPY OF BRONCHIAL CARCINOMAS. Schnepper, Elmar; Vielberg, Heinrich (Univ., Munster, Ger.). Strahlentherapie, 133: 176-83(June 1967). (In German).

Experiences and results obtained with ^{60}Co therapy in 121 patients with bronchial carcinomas during the years 1960 to 1963 in the Radiation Division of the Department of Surgery of the University Hospital in Muenster are reported. After describing the radiation technique and the analysis of the patient material, the early and late results observed after 3 to 6 years are interpreted. The most important advantage of the ^{60}Co teletherapy over conventional x-ray therapy is in the significant improvement of the early and palliative results. (auth)

36628 PHARMACOLOGICAL INFLUENCES ON THE DAILY RHYTHM VARIATIONS IN RADIATION EFFECTS AND THE QUESTION OF SEASONALLY CAUSED VARIATIONS IN THE RADIOSENSITIVITY OF RATS AND MICE. Fochem, Kurt; Michalica, Werner; Picha, Engelbert (Univ., Vienna). Strahlentherapie, 133: 256-61(June 1967). (In German).

Experiments done in rats and mice confirm the hypothesis that the deficiency in corticoid and 17-ketosteroid caused by the daily rhythm can be compensated by the administration of Adrenosane, Solu-Decortin, and Percorten; thus, the higher radiation sensitivity during irradiation in the evening can be compensated. The same effect could be obtained with the sulfhydryl compound Reducdyn. The dosage is an important factor for the outcome of the experiments. At the same time, it was observed that there is, in addition to a daily rhythm, a seasonal rhythm, which results in a complete inversion of the daily rhythm in the radiation sensitivity. (auth)

36629 POSSIBLE DETECTION OF CYSTIC FIBROSIS BY MEANS OF THE NEUTRON-ACTIVATION ANALYSIS OF FINGERNAILS. Andersen, G. H. (General Atomic Div., General Dynamics Corp., San Diego, Calif.); Gareis, F. J. Trans. Amer. Nucl. Soc., 10: 57(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36630 THE PROTECTIVE EFFECTS OF CHLOROQUINE DIPHOSPHATE ON THE SURVIVAL RATE OF MICE AFTER WHOLE-BODY IRRADIATION. Bielicky, Tibor; Zak, Miroslav (Charles Univ., Prague). Strahlentherapie, 133: 307-11(June 1967). (In German).

The effects of chloroquine diphosphate on survival rates of mice exposed to 600 R whole-body x radiation were investigated. It was observed that 20% of the mice died when 6.3 μg/kg of the drug were administered; 70% of the irradiated control animals died. Administration of lower or higher doses and administration at 0.5 hr postirradiation were not as effective; survival rates were lower than those of control groups. The mechanism of the protective effect of chloroquine diphosphate is discussed. (B.H.S.)

36631 INVESTIGATIONS ON BIOLOGICAL RADIATION PROTECTION, PART 79, EFFECTS OF RESERPINE, NARCOTICS, AND BODY TEMPERATURE ON UTILIZATION OF RADIOIRON WITH RADIATION-CONDITIONED INJURIES. Koch, Ruprecht; Seiter, Irma; Moenig, Hans (Univ., Freiburg i. B.). Strahlentherapie, 133: 296-306(June 1967). (In German).

The effects of fasting, megaphen, nembutal, reserpine, and a mixture of atosil, dolantin, and megaphen on ^{59}Fe metabolism in whole-body x-irradiated mice were studied. Reserpine provoked a drop in body temperature and a decrease in ^{59}Fe uptake; it also exerted a strong radioprotective effect. Protective effects were also observed with megaphen and the mixture of atosil, dolantin, and megaphen at a dose of 75 R. Fasting and nembutal decreased ^{59}Fe incorporation. (B.H.S.)

36632 RADIATION RESISTANCE IN PHARMACOLOGICALLY CHANGED PHAGOCYTIC ACTIVITY OF RES. Flemming, Kurt; Flemming, Christa; Graack, Barbara (Univ., Freiburg i. B.). Strahlentherapie, 133: 280-7(June 1967). (In German).

To test the concept that an increase in phagocytic activity in the reticulo-endothelial system (RES) was combined with increased tolerance to radiation, the influence of various agents (Pyrexal, Tace, Maytenus laevis-leaves, Scholler-Tornesch-lignin, olive oil, tricaprine, trioleine, ethyl palmitate, ethyl stearate, ethyl oleate) on phagocytosis and radiosensitivity, was compared in mice. All drugs that produced an increase in phagocytic activity also increased radioresistance. An analysis of dose–effect interrelations, however, showed that phagocytosis and radiosensitivity were influenced to different degrees. Since phagocytosis inhibiting agents (alkylesters of fatty acids) produced a radioprotective effect, it was concluded that there seemed to be no causal relation between phagocytic activity of the RES and radiation resistance. (auth)

36633 AN EVALUATION OF THE ^{85}Sr SCAN FOR THE DETECTION AND LOCALIZATION OF BONE METASTASES FROM PROSTATIC CARCINOMA: A PRELIMINARY REPORT OF 93 CASES. Faber, D. D.; Wahman, G. E.; Bailey, T. A.; Flocks, R. H.; Culp, D. A.; Morrison, R. T. (Univ. Hospitals, Iowa City, Iowa). J. Urol., 97: 526-32(Mar. 1967).

Usefulness of bone scans utilizing ^{85}Sr, as the nitrate, for the detection of metastases from carcinoma of the prostate was assessed. With a half-life of 65 days, ^{85}Sr decays by electron capture to ^{85}Rb with emission of a single γ photon of 0.513 MeV. The lack of α or β emissions results in a low radiation dose to bone, estimated to be from 0.8 to 2.28 rad. The gastrointestinal and urinary tracts are the principal routes of excretion of this isotope. The daily urinary excretion of the dose administered decreases from 20% during the first day to about 0.5% by the 14th day. Intestinal excretion is about 20% of the total excretion, and ~45% of the administered dose is retained 5 days after injection and becomes fixed in the skeleton. In 98 patients with various stages of prostatic carcinoma, an intravenous injection of 75 to 100 μCi of ^{85}Sr was made and the scans were obtained 4 to 14 days later. The results suggested that the ^{85}Sr bone scan is more sensitive than the skeletal radiograph in the detection of metastatic bone diseases. The scan is less specific and if abnormal, nonmalignant bone disease must be excluded. (BBB)

36634 EFFECT OF AMINOETHYLISOTHIOURONIUM Br.HBr (AET) ON THE CENTRAL NERVOUS SYSTEM OF PRENATALLY IRRADIATED RATS. Gol'dberg, M. B. (Inst. of Higher Nervous Activity and Neurophysiology, Moscow). Radiobiologiya, 7: 82-6(1967). (In Russian).

Male rats were irradiated with x rays at a dose of 150 R on the 16th day of embryogenesis. Fifteen minutes before irradiation AET was administered to the pregnant females in a dose of 200 mg/kg. The effect of AET on the central nervous system of prenatally irradiated rats during postnatal development was investigated by the conditioned reflex method. With respect to the facility in the development of conditioned reflexes, the rats protected with

AET were superior to rats irradiated in the same manner, but not protected with AET, and inferior to non-irradiated control rats. The results of the study of conditioned reflexes were confirmed by those obtained in the caffeine test: protected rats were more easily stimulated by caffeine than unprotected irradiated rats, but less readily than the non-irradiated control animals. AET did not exert a protective effect as far as deterioration of inner inhibition processes in irradiated rats was concerned. In postnatal development, the rats protected with AET had at the ages of 7 and 120 days a cerebral cortex of greater weight and thickness than unprotected irradiated rats and also a higher body weight, but were inferior in these respects to non-irradiated control rats. (JPRS)

36635 STUDIES OF SIEVE IRRADIATION. INHOMOGENEITY QUOTIENT AND BIOLOGICAL SIEVE EFFECT. Nakatsuka, Jiro (Kyoto Prefectural Univ., Kyoto). Nippon Igaku Hoshasen Gakkai Zasshi, 26: 963-74(Nov. 1966). (In Japanese).

Two important factors in sieve therapy are the field-size factor, i.e., the diameter of the hole and ratio of the open area, and the inhomogeneity quotient (IQ), which is the ratio of the maximum dose at the open area to the minimum dose at the covered area. The IQ is a high value on the surface, which decreases as the depth increases, and the lower the IQ the less the biological sieve effect ratio (BSER). It is generally considered that at the depth where IQ becomes less than two, there is no biological sieve effect (BSE). There are only a few papers demonstrating the relationship between IQ at various depths and its related BSE. The relation between BSER and IQ for ^{60}Co γ irradiation and x irradiation at various depths was studied. The LD 50/30 and median survival time after whole-body irradiation was evaluated. Probit analysis was used to estimate the experimental results. (TSS) (NSA of Japan)

36636 MEGAVOLTAGE THERAPY FOR GYNECOLOGIC MALIGNANCIES. Holzaepfel, John H.; Pomeroy, Thomas C. (Ohio State Univ., Columbus). Amer. J. Obstet. Gynecol., 97: 625-34(Mar. 1, 1967).

Complications occurring in the course of treatment of 251 cases of cervical cancer with ^{60}Co teletherapy, ^{60}Co intrauterine applicators, and with the betatron are described. The use of an 8-sided diaphragm, consisting of a series of lead blocks that can be opened and closed proportionally to form fields of various sizes and shapes, is described for use with ^{60}Co teletherapy. This permits continuous adjustments to square, rectangular, or octagonal treatment areas from 2 by 2 to 20 by 20 cm. The planar isodose curve is shown, revealing that the maximum intensity point of delivery is 4 cm lateral to the midline. Eccentric positioning of the patient provided this dose configuration. It permitted the proper balance with the isodose pattern delivered by ^{60}Co in a central colpostat and tandem. It provided greater protection to midline adjacent bladder and bowel. Complications, which occurred in 12% of the patients, included the following: vesicovaginal fistulas 6, rectovaginal fistulas 4, ureteral obstruction 6, kidney injury 2, severe radiation proctitis 3, and vaginal stenosis 3. Colostomy was required in 3, cordotomy in 3, and ureterostomy in 1. (BBB)

36637 ISOTOPIC DETECTION OF THROMBI. Spar, Irving L.; Varon, Myron I.; Goodland, Ruth L.; Schwartz, Seymour I. (Univ. of Rochester, N. Y.). Arch. Surg., 92: 752-8(May 1966). (UR-49-691).

Purified rabbit antibody to human fibrinogen labeled with ^{131}I was used to detect peripheral venous thrombi by scintillation scanning techniques. In nine consecutive patients injected with this preparation, femoral, popliteal, and calf lesions were found by this technique. Verification of thrombus location was made in most instances by phlebography. In other studies, patients with atrial thrombi or with a pulmonary infarct were studied. Areas of increased ^{131}I concentration were found by scanning in those cases where later surgical or x-ray verification was made. It is suggested that the technique of scintillation scanning after administration of ^{131}I antihuman fibrinogen may be a valuable screening and diagnostic procedure for locating peripheral thrombi as well as similar lesions in other areas. (auth)

36638 ON THE APPLICATION OF ^{131}I-ANTIFIBRINOGEN TO THE DIAGNOSIS OF MALIGNANT TUMORS. Takaki, Hidetoshi (Kurume Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 26: 1281-98(Jan. 1967). (In Japanese).

The use of ^{131}I-antifibrinogen as a tracer for scintillation counting in the diagnosis of malignant tumors was tested in rabbits and men. Iodine-131-labeled antirabbit-fowl-fibrinogen antibody was localized in neoplasms of the lung, lymphosarcoma, and brain metastases of lung cancer. The best scintigrams were obtained 72 hr after injection of the antibody. (TSS)

36639 TEN YEARS END RESULTS OF RADIOLOGICAL TREATMENT OF CARCINOMA OF THE UTERINE CERVIX IN INSTITUTE OF ONCOLOGY IN WARSAY. Tarlowska, L.; Jentys, W.; Lukawska, K.; Sablinska, B.; Swiatkowska, H. (Institut M. Sklodowska-Curie, Warsaw). Radiobiol.-Radiother., 7: 673-6(1966).

The results of radiological treatment of 2,436 patients with invasive carcinoma of the cervix are presented. Ten years end results, which are a better index of stability of cure than the generally accepted 5 years index, were calculated for that group of patients. (auth)

36640 RECTAL RADIATION INJURIES FOLLOWING THERAPY OF COLLUM CARCINOMA WITH MODIFIED PARIS METHOD. Medvey, W.; Szymczyk, W. (Onkologische Institut, Krakow). Radiobiol.-Radiother., 7: 693-7(1966). (In Polish).

Based on the material examined rectal radiation injuries most frequently occur in the first two years after treatment for stages I and II with an average age of 47 years. Exceeding the dose of 5100 R to point A with the modified Paris method will increase rectal radiation injuries. A dependence on the method of treatment could not be statistically assured. (auth)

36641 THERAPY OF CORPUS CARCINOMAS AND UTERUS SARCOMAS. Brauer, W. (Staedtische Klinikum, Berlin). Radiobiol.-Radiother., 7: 707-19(1966). (In German).

From 1954 until 1960 87 patients were treated for corpus carcinoma, 5 patients for uterus sarcoma and 10 patients for adenocarcinoma of collum uteri. Out of 52 patients being operated and postirradiated for corpus carcinoma, 38 patients survived 5 years without symptoms (73%); for all 87 corpus carcinomas efficiency number is 58%. The hitherto existing reporting is criticized. The subdivision of malignant uterus neoplasmas according to localization does not meet radiotherapeutical interests; a classification according to histology would be more suitable. If the hitherto used kind of reporting is kept the other adenocarcinomas of the uterus should be reported supplementarily, too. The material of 104 patients contains nine patients with malignant double tumors. (auth)

36642 LATE RESULTS BEYOND THE 5-YEARS LIMIT IN CARCINOMA CORPORIS UTERI AFTER RADIATION THERAPY ONLY COMPARED WITH THE RESULTS AFTER SURGICAL-RADIOLOGICAL TREATMENT. Janisch-Raskovic, W. (Staedtische Frauenklinik, Karl-Marx-Stadt, Ger.). Radiobiol.-Radiother., 7: 721-8(1966). (In German).

Among 82 operated and postirradiated corpus carcinomas healed after 5 years as well as 126 corpus carcinomas treated by x rays and radium from 1926 to 1948 8 reoccurred after 7 to 9 years treatment, 7 patients died among them one operated (vaginal recidivation). One patient died 17 years later of a malignant histologically not verified corpus-collum neoplasm and another one died 16 years later of a polymorphic sarcoma of the portio. A radioinduced neoplasm is discussed. Five among these 8 recidivations and the portio sarcoma were curable and received an adequate therapy. One patient only with a recidivation in the uterine cavity was healed by radium x-irradiation and is without symptoms for the last 16 years. Two operated and 5 irradiated patients died of clinical supposed intraabdominal metastases 7 to 15 years after treatment, 16 neoplasms of other organs 5 of them being only clinically, 11 histologically, roentgenologically or by autopsy verified, among them 8 carcinomas in the stomach. Mortality of neoplasms of the hitherto died 5 years healed patients is under consideration of the only clinically stated cases of death. (auth)

36643 EXPERIENCES AND RESULTS IN COMBINATED RADIO-CYTOSTATIC TREATMENT OF OPERATED GLIOBLASTOMAS. Ott, J.; Richter, H. H. (Chirurgische Univ., Greifswald, Ger.). Radiobiol.-Radiother., 7: 739-42(1966). (In German).

Thirty two cases of glioblastomas, partly inoperable, partly subtotally operated, were reported. The first group was postirradiated in the conventional way, the second group was treated with cytostatics after irradiation. The possibility of an additive effect in the second group will be discussed. Comparing the average survival an increase following the combined cytostatic therapy is to be found. (auth)

36644 THE EFFECTS OF X-IRRADIATION ON THE TREATED AMPHIBIAN LARVAE IN 2,4-DINITROPHENOL AND AZAID. Tanaka, Norimoto (Kyoto Prefectural Univ. of Medicine). Nippon Igaku Hoshasen Gakkai Zasshi, 26: 1384-7(Jan. 1967). (In Japanese).

The effects of DNP (10^{-4} M) and azaid (1/200) administered prior to x irradiation on the post-irradiation survival of larvae of Rhacophorus arboreus were studied. It is well known that the administration of DNP prior to x irradiation in the animal embryo (Taguchi et al.) and the mammal (Bonet-Maury et al. and other authors) protects the subjects against radiation, and the effect on radiosensitivity is probably caused by the change of the oxygen content of the cells. In present studies a slightly pro-

longed survival in larvae treated with DNP after a dose of 1,200 R was recorded. In the case of azaid, an increased survival was recorded in larvae treated with azaid after a dose of 900 R, but with dose of 1,800 R and treatment after irradiation no such increase was observed. Results are discussed. (NSA of Japan)

36645 AIMED SHOCK AS THERAPEUTIC AGENT AFTER LETHAL WHOLE-BODY IRRADIATION. Gabler, Eduard; Stoeckl, Wilhelm (Tieraerztliche Hochschule, Vienna). Strahlentherapie, 133: 117-25(May 1967). (In German).

Survival rates were obtained in guinea pigs, albino rats and, to some degree, in mice by producing an anaphylactic reaction with calf serum, human gamma globulin, and complete Freunds' adjuvant immediately after lethal whole-body x-irradiation as well as by administration of shock producing substances (compound 48/80, Anaphylatoxine, Coli-Andotoxine, Adrenosan, and Alupent) about 5 to 20 min after the lethal radiation exposure. Results obtained with Alupent are discussed in detail. In addition to repair mechanisms, the building of a shock tolerance against a fatal shock-like state within the acute radiation syndrome was thought to be responsible for the effect observed. (auth)

36646 PREPARATION OF TOOTH ENAMELS WITH THE LASER BEAM. Schulte, W. (Univ., Tuebingen, Ger.). Zahnaerztl. Mitt., 54: 892-4(1964). (In German).

To ascertain the possibility of using a laser beam as a substitute for a mechanical dental drill a ruby laser equipment with 40-J energy and with a light pulse interval of 2 to 3 minutes, that produced a burned area 1 to 1.5 mm diameter in metal or paper, was tested with extracted human teeth. After exposure to one or several laser pulses of equal intensity at the same point the healthy, smooth enamel surface became roughened. The area affected was 8 or 10 times the size of the burn point, almost circular, and showed a diamond edge surface macroscopically as well as under magnification. Staining of the enamel surface with dye to alter the reflection characteristics did not alter the laser effects. A defect became visible in carious, dark brown dentin after 5 laser pulses. Its diameter was approximately the same as the burn area of the laser beam, and was ~1 mm deep. The odor characteristics of heated dentin was noticeable briefly after exposure of dentin to the laser beam, but not after the enamel was exposed to the beam. Because of the short, 2-msec duration of the beam the temperature rise, as measured by thermocouples inserted in the pulp cavities was very transient. The teeth were not warm to the touch. It is concluded that much additional study must be completed before it will be definitely known that the laser beam is suitable for use in place of a mechanical drill. (BBB)

36647 DEVELOPMENT OF A LOW-BACKGROUND NEUTRON AUTORADIOGRAPHIC TECHNIQUE. Fairchild, R. G.; Tonna, E. A.; Seibold, Clara T. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Radiat. Res., 30: 774-87 (Apr. 1967). (BNL-10305).

The cellular distribution of ^{10}B in tissue is of interest in neutron capture therapy, since the efficacy of the $^{10}B(n,\alpha)^7Li$ reaction is dependent on localization within cells. Experimental results showed that air nitrogen in conjunction with emulsion of greater than optimum thickness was responsible for high background encountered in previous attempts to develop a technique capable of determining intracellular distribution in human tissues. Irradiation of glass slides coated with 1.3 microns of Kodak NTA liquid emulsion, with a thermal neutron fluence of 6.23×10^{10} cm^{-2} in a CO_2 atmosphere, gave a heavy-particle background of 2 tracks per microscopic field (1.77×10^{-4} cm^2). If a tissue section 5 microns thick, containing 60 μg of ^{10}B per gram of tissue (roughly the maximum amount tolerable to human tissues) is irradiated with the same fluence, the number of countable α-tracks per field from the $^{10}B(n,\alpha)^7Li$ reaction would be 25.6 or 10.2 tracks per field, depending on whether or not attenuation in tissue was taken into consideration. Both of the above numbers were verified by experiment. Therefore, it is now possible to determine the intracellular distribution of ^{10}B in human tissues. It was concluded that the residual background was due to thermal neutron activation of nitrogen and silver in the emulsion. Since an emulsion thickness close to the optimum was used, further reduction in background would be difficult. Utilization of short development times and short times between irradiation and development failed to significantly reduce background relative to the number of α-tracks. Lucite slides were found to offer no advantage over glass slides. (auth)

36648 THE PROTECTIVE EFFECT OF CYSTEAMINE DURING IRRADIATION OF DNA- AND RNA-CONTAINING BACTERIOPHAGES IN BROTH. Vinetskii, Yu. P. (Inst. of Biophysics, Moscow). Radiobiologiya, 7: 93-5(1967). (In Russian).

On irradiation with γ rays of the RNA-containing E. coli phage MS-2 and the DNA-containing E. coli phage X174 in broth in the presence of cysteamine, it was established that hyperprotection was exerted by this agent. The degree of protection by cysteamine in concentrations of 10^{-2} to 1M was unequal for the two phages. It is assumed on the basis of this result that the mechanisms by which RNA and DNA were damaged under the direct action of ionizing radiation were not the same. (JPRS)

36649 CHARACTERISTICS OF ACCUMULATION OF NEUTRAL RED IN THE ORGANS OF MICE AT VARIOUS INTERVALS AFTER ADMINISTRATION OF RADIOPROTECTIVE SUBSTANCES. Zherebchenko, P. G.; Zaitseva, T. G. (Kirov Military Medical Academy, Leningrad). Radiobiologiya, 7: 105-10 (1967). (In Russian).

Simultaneous intraperitoneal injection of aminothiols and indolylalkylamines to mice before irradiation increases the protective effect against radiation. On the other hand, administration of 5-methoxytryptamine (5-MOT) a second time 4 hrs after the first application or 4 hrs after administration of cystamine reduced the toxicity, vasoconstrictive effect, and the radioprotective effect of 5-MOT. To check whether this reduction of activity is related to changes in the permeability of histohematic barriers and of the hematoencephalic barrier, the accumulation of neutral red (NR) in various organs of mice to which 5-MOT or cystamine had been administered was studied. On administration of NR to mice at various times after injection of 5-MOT or cystamine, accumulation of NR in the organs proceeded differently than on administration of this dye simultaneously with the protective agents. Specifically, delayed action of the protective agents reduced the amount of NR accumulated in the brain. The initial effect of 5-MOT in promoting accumulation of NR in the brain decreased on repeated administration of 5-MOT or its administration after cystamine. Changes in the accumulation of NR in organs similar to those associated with the action of the protective agents in late periods after administration were produced by administration of ACTH or cortisone. The capacity of cystamine or 5-MOT to bring about an initial increase in the accumulation of NR in the brain was reduced when ACTH or cortisone had been administered to the mice. After administration of ACTH or cortisone, the toxicity of cystamine and 5-MOT, the vasoconstrictive effect of 5-MOT (as indicated by the blood loss of mice after their tail had been cut off), and the protective effect of 5-MOT (but not of cystamine) against radiation were reduced. The results indicated that 5-MOT lowered the permeability of the hematoencephalic barrier after first increasing it. The aftereffect was due to stimulation of the hypophyso-adrenal system by 5-MOT and consequently could be reproduced by means of ACTH or cortisone. Because of lowering of the permeability of the hematoencephalic barrier, the central component of the vasoconstrictive action of 5-MOT, on which its protective effect against radiation depends, was reduced. (JPRS)

36650 A CORRELATION BETWEEN RADIATION-INDUCED FREE RADICALS AND SURVIVAL IN MICRO-ORGANISMS EXPOSED TO β-MERCAPTOETHYLAMINE UNDER OXYGEN OR NITROGEN. Swartz, Harold M.; Richardson, Earl C. (Walter Reed Army Inst. of Research, Washington, D. C.). Int. J. Radiat. Biol., 12: 75-88(1967).

Both free radical and survival measurements were made on the same samples of microorganisms irradiated at –196°C. Under these conditions, which minimized indirect effects, pronounced oxygen (radiosensitization) and MEA (radioprotection) effects were observed. MEA protected in the presence of N_2 or O_2. The reduction in certain types of bacterial radicals by MEA correlated with an increase in bacterial survival. Sulfur-type radicals were not found. A relation exists between free-radical reduction and radiation protection; MEA is in contact with the protected biological molecules; transfer of unpaired electrons to the sulfur nucleus in MEA is not required for radiation protection; MEA protection includes a mechanism that does not involve competition with oxygen; and the oxygen-effect involves direct interaction of oxygen with biological molecules. (auth)

36651 BIOSYNTHESIS OF INOSINIC ACID IN THE HYALOPLASM OF PIGEON LIVER ON INTRODUCTION OF A RADIOPROTECTIVE SUBSTANCE. Romantsev, E. F.; Khalikov, S. K. (Inst. of Biophysics, Moscow). Radiobiologiya, 7: 127-9(1967). (In Russian).

It was established in earlier work that upon intraperitoneal injection into pigeons of β-thiopropylamine in doses exerting a protective effect against radiation, the synthesis of inosinic acid in liver homogenates was strongly inhibited. It was found that the synthesis in vitro of inosinic acid, inosine, and hypoxanthine in the hyaloplasm of pigeon liver was inhibited on addition of β-thiopropylamine, as shown by determinations of radioactivity after introducing 2-^{14}C-formate, which is included in the molecule in the biosynthesis of purines. On intraperitoneal injection into pigeons of β-thiopropylamine in doses that exerted a protective

effect against radiation injury, the synthesis of inosinic acid in the liver hyaloplasm was also inhibited. (JPRS)

36652 ACTION OF CHEMICAL RADIATION PROTECTORS UNDER CONDITIONS OF FRACTIONATED IRRADIATION. IV. PROTECTIVE EFFECT ON INJECTION OF THE RADIATION PROTECTORS DURING IRRADIATION. Yarmonenko, S. P. (Inst. of Labor Hygiene and Occupational Diseases, Moscow). Radiobiologiya, 7: 100-4(1967). (In Russian).

The protective effect of the monosodium salt of β-aminoethylthiophosphoric acid (cystaphos) and of its complex with 5-methoxytryptamine (mexamine) against radiation injury was studied after intraperitoneal injection into x irradiated mice. In the first series of experiments, irradiation was interrupted after 150, 300, and 450 R had been applied, then cystaphos was administered and irradiation was resumed until an additional dose of 675, 450, and 225 R had been applied. Under consideration of the factor of dose weakening (FDW) for cystaphos, which is equal to 1.5, this corresponded to irradiation with a total dose of about 600 R in every case, which constituted the $LD_{50/30}$ for the animals. The experiments with the complex were conducted similarly: to apply a total effective dose of about 600 R ($LD_{50/30}$), the animals were irradiated with 150, 300, and 450 R and then, on administration of the complex (FDW = 1.9), with an additional dose of 850, 570, and 285 R, respectively. In both series of experiments, the actual effect corresponded to that calculated on the basis of the FDW—i.e., about 50% of the animals died before the 30th day after irradiation. By using as a criterion the number of karyocytes in the bone marrow of the femur of the animals on the 3rd day after irradiation, FDW values of 1.5, 2, and 3 were found for cystaphos, mexamine, and the complex, respectively, independently of the dose of radiation applied (300, 450, or 600 R). Data on the action of protective substances applied after irradiation are of importance from the standpoint of measures to be taken in emergencies and accidents as well as under conditions produced by solar flares during space flights. (JPRS)

36653 A STUDY ON LUNG SCINTISCANNING WITH ^{131}I-MACROAGGREGATED ALBUMIN. Nakata, Hajime (Kyushu Univ., Fukuoka). Nippon Igaku Hoshasen Gakkai Zasshi, 27: 1-18(Apr. 1967). (In Japanese).

Lung scintiscanning with ^{131}I-macroaggregated albumin (MAA) was developed as a diagnostic aid for pulmonary embolism. In this study, its usefulness in diagnosis of other lung diseases and its comparison with pulmonary angiography were investigated. Also, the distribution of ^{131}I-MAA in lungs and other organs and requirements for the measuring apparatus were studied. The experiments with adult rabbits revealed that more than 90% of the injected ^{131}I-MAA gathered in the lungs immediately after the injection into the auricular vein. The activity did not change for 1 hr, but after 24 hrs only 2% of the injected material remained in the lungs. In clinical cases, 85% of the injected dose was excreted in urine in 48 hrs. Also, the sparse distribution of ^{131}I-MAA embolism in pulmonary arteriole was ascertained by microautoradiographs. The collimator of choice was a honey-comb cone with 37 holes and the focus of 10 cm. The spherical defect of the radioisotope in the homogeneously distributed ^{131}I was used to evaluate the detecting ability of this collimator. The minimum diameter which was detected with this collimator was 3 cm. to 5 cm. Compared with roentgenography, lung scintigraphy has little diagnostic value in 45 cases of lung diseases other than pulmonary embolism. Only in the so-called hilar types of bronchogenic carcinoma, a remarkable decrease in radioactivity on lung scintigram was noted, and this could be some diagnostic aid. Lung scintiscanning was found rather superior to pulmonary angiography as for the ability to detect an abnormality in pulmonary blood flow and could easily make the quantitative comparisons in local pulmonary blood flow. Therefore this is considered to be an excellent screening test prior to subjecting a patient to pulmonary angiography. (NSA of Japan)

36654 EFFECT OF THE COMBINED TREATMENT OF RADIATION AND CARCINOSTATIC AGENTS ON YOSHIDA SARCOMA CELLS. Adachi, Tadashi; Saito, Toshitaka (Tokyo Medical and Dental Univ.). Bull. Tokyo Med. Dent. Univ., 13: 445-66(Dec. 1966).

Rats in which Yoshida sarcoma cells had been inoculated were treated by radiation and/or carcinostatic agents. Yoshida sarcoma cells obtained from the rats were then retransplanted to normal rats. The therapeutic effect of radiation and/or carcinostatic agents was examined by the mean survival days of the latter rats. A larger dose of radiation or carcinostatic agents gave a larger effect. A single irradiation of 1500 R was more effective than fractionated irradiation of the same total dose; but there was no significant difference between 500 R × 3 and 300 R × 5. Any type of treatment, single or combined treatment, after transplantation of Yoshida sarcoma cells, was more effective at the early than at the later stage. The irradiation followed by administration of carcinostatic agent and the simultaneous irradiation and administration were more effective than administration followed by irradiation. The latter was frequently less effective than the single administration or irradiation. The results of experiments indicated the behavior of metastasis after treatment of the primary lesion of cancer, and also supported the clinical experience that the treatment of cancer should be directed toward maintenance and good general condition of the host as well as destruction of malignant cells. (NSA of Japan)

36655 THEORETICAL CONSIDERATIONS ON THE INFLUENCE OF DOSE FRACTIONATION ON EFFECTIVENESS OF RADIATION THERAPY. Suit, Herman D.; Wette, Reimut (Univ. of Texas, Houston). Nat. Cancer Inst. Monogr., No. 24, 225-41 (Feb. 1967).

Factors are considered which affect the relation between the probability of achieving a tumor cure with a specified dose of radiation, number of fractions into which the dose is divided, and time the treatment is extended. The characteristics of a tumor model that is biologically plausible and convenient are outlined. A mathematical model is also developed for the representation of the lethal response of cells and of cell populations to ionizing radiation. The effects of four factors on the probability of tumor cure by fractionated irradiation are discussed with reference to the model. These factors are: cell radiosensitivity, number of equal dose fractions, cell reproduction between dose fractions, and frequency of natural mortality of the cells (i.e., nonradiation death). Reference is also made to results of fractionated irradiation of lab animal-tumor systems. Implications for clinical radiotherapy of these theoretical considerations are appraised. It is suggested that, for the present, the most profitable investigations on the importance of the number of fractions and the time between treatments would be predominately those on tissues of experimental animals. (BBB)

36656 THE EXPERIMENTAL PRODUCTION OF DRUG PHOTOTOXICITY IN GUINEA PIGS. I. USING SUNLIGHT. Sams, W. Mitchell Jr.; Epstein, John H. (Letterman General Hospital, San Francisco). J. Invest. Dermatol., 48: 89-94(1967).

The effect of the uv components of sunlight in phototoxicity reactions in guinea pigs was studied. A reliable and reproducible demonstration of drug phototoxicity in guinea pigs, using sunlight as the source of uv, was obtained with chloropromazine, demethychlortetracycline, and chlorothiazide. Following intraperitoneal injection of the drug, the animals were exposed to sunlight for varying periods of time. A positive response was characterized by a brisk erythema and later by necrosis and ulceration of the ears of the experimental animals. This was in striking contrast to the relatively mild reaction in the control animals. Most of the phototoxic reaction was due to wavelengths longer than 3100 Å, as shown by the fact that Mylar plastic, which absorbs all wavelengths below 3100 Å, prevented normal erythema from developing in the control animals but had no effect on the phototoxic response. Thus, the use of Mylar represents a unique means of enhancing the contrast between the control and the experimental animals. (BBB)

36657 MOTOR RESPONSE OF THE GALL BLADDER DURING RADIATION SICKNESS. Chachava, A. V. (Tbilisi State Univ.). Soobshch. Akad. Nauk Gruz. SSR, 46: 243-8(Apr. 1967). (In Russian).

Experiments were carried out with 15 dogs exposed to x radiation from a RUT-200 apparatus and 48 monkeys exposed to 590 rad from a cobalt device, at dose rates of about 100 rad/min in order to induce acute radiation sickness and 1 to 4.5 R with a total dose of 98 to 1500 rad for inducing chronic sickness. At the initial stages of the acute sickness the tonus and evacuation from the gall bladder increased; during the latent period and the most acute periods of sickness the tonus and evacuation were inhibited. The functions of the gall bladder were usually normal after the animal recovered, and no secondary effects were observed. During chronic radiation sickness both the tonus and evacuation were inhibited. (R.V.J.)

36658 ON-LINE COMPUTERS IN NUCLEAR RESEARCH. PART IV. PROGRESS WITH COMPUTERS IN NUCLEAR MEDICINE. Smith, Edward M. (Univ. of Miami, Fla.); Brill, A. Bertrand. Nucleonics, 25: No. 5, 64-71(May 1967).

Computer techniques are assuming a major role in dynamic function studies using radioisotopes as tracers where the ability to collect and analyze multiple digitized pictures of the organ distribution of the labeled compound provides insight into regional physiology and pathology. Computers tied to scanning systems are also being used in routine clinical nuclear medicine laboratories and automation of in vitro tests is becoming commonplace. Techniques include everything from routine clinical sample counting to the complex system encountered in activation analysis.

Various systems used for data acquisition, storage, control, and display are reviewed and data are summarized on typical off-line computer systems used at 10 nuclear medicine centers. (49 references.) (C.H.)

36659 RADIOACTIVE PHOSPHORUS (^{32}P) FOR THE COMPLEX-THERAPY OF CARCINOMA OF THE BREAST. Dragon, V.; Voiculetz, N.; Trestioreanu, Al.; Horodniceanu, Elena (Institut Oncologique, Bucharest). Radiobiol.-Radiother., 8: No. 1, 27-33(1967). (In French).

Between 1958 and 1961 radioactive phosphorus (^{32}P) was used for the complex-treatment of carcinoma of the breast in 113 patients at the Oncological Institute of Bucharest. For 100 patients radiophosphorus was prescribed with respect to the prophylaxis of bone metastases. All cases had been radiosurgically treated (x ray therapy and operation according to Halsted). Fifteen patients were clinical stage I, 52 stage II, 33 stage III A. One mCi ^{32}P was given orally per week up to a total dose of 3 to 20 mCi (on the average 7 mCi). All patients were followed up between 5 and 8 years. Bone metastases occurred in 15 percent. The curative quota was 66.6 per cent for stage I, 61.5 per cent for stage II, and 39.4 per cent for stage IIIA. For 13 patients radiophosphorus was prescribed with a palliative aim of therapy because secondary bone metastases of an unoperated or an operated carcinoma of the breast were present. The total doses of ^{32}P administered orally were between 4 and 15 mCi (on the average 7 mCi). The average survival in this group of 13 patients (from the development of metastases forth) was 14.3 months. For those cases who showed a single bone-metastasis only it was higher, i.e. 19.4 months. (auth)

36660 THE RESULTS OF OVARIAN CARCINOMAS TREATED INTRAPERITONEALLY WITH RADIOGOLD (^{198}Au) AT THE GESCHWULSTKLINIK OF CHARITE, BERLIN. Doerffel, E. W.; Nguyen Van Hai (Humboldt-Univ., Berlin). Radiobiol.-Radiother., 8: No. 1, 35-41(1967). (In German).

The 5-year recovery for the intraperitoneal treatment of ovarian carcinomas with radiogold is discussed. The precalculation according to the method of Kunz and Sinner yields a preliminary 5-years survival quota of 30 per cent for all patients. For our group I (prophylactic treatment) the quota probably is about 60 per cent, for group III (palliative treatment) about 9 per cent, for group II (curative treatment) a prediction is not yet possible. A radical operation with hysterectomy and bilateral salpingo-oophorectomy is recommended. For physical and geometrical reasons it is believed that leaving the uterus as a carrier of radium is reasonable. If there are macroscopically no remainders left, one prophylactic intraperitoneal installation of radiogold after one to three weeks will suffice. This prophylactic treatment quite surely annihilates a submacroscopical dissemination and has no considerable risk. If there are remainders left by operation or the radicality is doubted, an external irradiation has to immediately follow the first treatment with radiogold. If there was already present a military peritoneal dissemination, a second instillation of radiogold should be performed. Palliatively the treatment with radiogold has an advantageous effect in about the half of cases; larger metastases cannot be influenced for physical reasons. For cachectic patients and inoperable tumors radiogold therapy has an unfavourable effect. Cooperation between gynecologists and radiologists is stressed. (auth)

36661 THE DIAGNOSIS OF BONE-TUMORS WITH ^{85}Sr. Hliniak, A.; Tenner, J. (Onkologische Institut, Gliwice, Poland). Radiobiol.-Radiother., 8: No. 1, 43-5(1967). (In German).

According to our existing observations the ^{85}Sr-test with the apparatus described does not yield a reliable criterion for patients with bone metastases in the case of cancer of the breast. The results of the test in two observed cases of primary bone tumors point to the necessity of further examinations. (auth)

36662 ON THE CLINICAL COURSE OF REPEATED ACUTE RADIATION SICKNESS. Gorizontov, P. D.; Raeva, N. V.; Akoev, I. G. Radiobiologiya, 6: 920-1(1966). (In Russian).

The frequency of the simultaneous appearance of clinical symptoms of radiation sickness in the case of primary and secondary radiation traumas, equivalent in irradiation dose, was compared in investigations on dogs surviving after irradiation at doses of $LD_{50-30/30}$ as a result of the administration of a therapeutic prophylactic complex and subjected to repeated irradiation at the same doses. A group of dogs irradiated once with equivalent doses and not administered prophylactic and therapeutic remedies served as the control. Definite differences in the clinical manifestations of primary and secondary radiation trauma were noted. Such symptoms as general depression, reduced appetite, increase in body temperature, hemorrhages, and diarrhea were noted in a smaller percentage of cases in the case of repeated radiation sickness than in the case of the primary trauma. Ulceration of the mucosa and edema was encountered more often in the case of repeated radiation sickness. The repeated radiation sickness took a more torpid course in general. It showed a tendency to appear earlier and last longer. (JPRS)

36663 INFLUENCE OF CYSTAMINE ON THE CHANGES IN THE WHITE BLOOD CELLS OF DOGS AFTER SUBLETHAL X IRRADIATION. Makhalova, O. K.; Mozzhukhin, A. S.; Bertash, V. I. (Military Medical Academy, Leningrad). Radiobiologiya, 6: 883-5(1966). (In Russian).

Intravenous administration of cystamine hydrochloride (60 mg/kg) to dogs before 300 R x irradiation at a dose rate of 7.4 R/min, reduced the clinical symptoms of acute radiation sickness and the degree of expression of the changes in the white blood cells. The prophylactic administration of cystamine not only promoted a decrease in the changes in the white blood cells, but also an acceleration of the recovery processes in this system. A comparison with data on the protective effects of cystamine and AET on blood cells after lethal and sublethal irradiation indicated that the protective action of radioprotectors with respect to the blood cells was more pronounced in the case of lethal irradiation. (JPRS)

36664 ON THE MODIFYING ACTION OF SERUM PROTEINS ON THE DOSE DEPENDENCE OF RADIATION INJURY OF ERYTHROCYTES. Orlova, L. V.; Trincher, K. S. (Inst. of Biological Physics, Moscow). Radiobiologiya, 6: 915-16(1966). (In Russian).

The dose dependence of radiation injury to the erythrocytes of newborn and adult rats was studied under natural conditions (γ irradiation of whole blood at doses of 5, 10, 15, 20, and 40 kR at a dose rate of 700 R/min. At doses above 15 kR, in addition to injury to the highly radiosensitive α-components, damage to the membranes according to a five-hit mechanism (β-components) appears. This injury was substantially more pronounced in the case of irradiation of a suspension of erythrocytes from newborn rats as compared to those of adult rats, in the dose region from approximately 25 to 40 kR. This effect was not observed in the irradiation of erythrocytes under native conditions, in whole blood, evidently due to blockage of the radioresistant β-components in the erythrocyte membrane by the extracellular protein molecules adsorbed on the cell surface. The erythrocyte membrane of newborn rats was found to contain more radioresistant β-components than the erythrocyte membrane of adult animals. (JPRS)

36665 ON THE MECHANISM OF THE ORIGIN OF SPONTANEOUS AND RADIATION-INDUCED CHROMOSOME BREAKAGE IN MAMMALIAN BONE MARROW CELLS. Rukavishnikov, Yu. M. Radiobiologiya, 6: 869-74(1966). (In Russian).

An investigation of the possibility of using bivalent cations to minimize radiation response was predicated upon the assumption that if the ion concentration is increased with a simultaneous administration of a protector of the amino acid type, then the net effect of these agents may be substantial. Experiments on a mixed population of white mice, subjected to whole-body x irradiation at doses of 50, 100, and 200 R, corroborated the significance of mineral metabolism in the radiosensitivity of mammalian cells. Calcium chloride and parathyroidin, administered before irradiation, protect bone marrow cells from the mutagenic effects of radiation at doses of up to 200 R. The protective effect is enhanced by the administration of these substances in conjunction with proline. The possibility of experimental reduction of the frequency of spontaneous chromosome rearrangements in mammals was demonstrated. (JPRS)

36666 RADIOACTIVE PHOSPHORUS IN THE DIFFERENTIAL DIAGNOSIS OF THE MALIGNANT LYMPHOMA AND TUBERCULOUS LYMPHADENITIS. Nakatsuka, Haruo; Fukui, Yoshinori (Osaka City Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 26: 988-92(Nov. 1966).

Eight selected patients with malignant and tuberculous lymphoma were studied by means of an end-window Geiger-Mueller counter for β particle surface activity following intravenous administration of ^{32}P. Surface activity on normal skin appeared at once, reached maximum within twenty minutes after intravenous administration, and decreased approximately exponentially after 1 to 2 days. Surface activity over the superficial lumphosarcoma and reticulosarcoma at the neck was 1.3 to 1.5 times that in normal comparable area as long as two weeks. Counting rate over the tuberculous lymphoma appeared only a little higher than the control area for first 1 to 2 days, and thereafter appeared not outside the normal range. (NSA of Japan)

36667 THE PROTECTIVE EFFECTS OF SOME NARCOTIC SUBSTANCES AGAINST X-IRRADIATION ON AQUATIC ANIMALS. 2. PROTECTIVE EFFECTS OF ETHYL ALCOHOL. Tanaka, Norimoto (Kyoto Prefectural Univ. of Medicine). Nippon Igaku Hoshasen Gakkai Zasshi, 26: 1012-15(Nov. 1966).

Unlike mammals, larvae of Rana nigromaculata did not show

any recovery phenomena from three fractionated radiation doses spaced at 24 hour intervals. Survival rates were similarly less after fractionated exposure. Protective action of ethyl alcohol on x irradiated Rana nigromaculata larvae was demonstrated. The mechanism of protection, is in agreement with a previous proposal that alcohol must rapidly be metabolized by cells and therefore it lowers the intracellular oxygen tension to give the protective effect. However the protection of this drug may be partially related to its chemical properties. (NSA of Japan)

36668 RADIOLOGIC CLASSIFICATION OF PNEUMOCONIOSES. AN ANGLO-AMERICAN RADIOGRAPH READING EXERCISE AND STUDY OF THE INTERNATIONAL LABOR OFFICE (1958) CLASSIFICATION OF THE PNEUMOCONIOSES: A COOPERATIVE STUDY. Arch. Environ. Health, 12: 314-30(Mar. 1966).

A radiographic reading exercise combined with a study of the International Labor Office Radiological Classification of the Pneumoconioses (1958) by groups of observers from the United States and the United Kingdom is reported. Reading methods and standards were compared by an exchange of chest radiographs on two occasions, one before a joint meeting and discussion and one after. The method by which these readings were carried out is presented, and the statistical methods used to analyze results are described. Significant differences between the American and British groups, and within each group, were found. The reasons for these discrepancies are discussed, and modifications of the definitions of categories in the classification are suggested. It is believed these would lead to a more uniform interpretation of chest radiographs showing pneumoconioses. (auth) (Occup. Safety and Health Abstr.)

36669 SUPERFICIAL BEHAVIOR OF THE HEART X-RAY SHADOW IN CHRONIC LUNG DISEASES, ESPECIALLY SILICOSIS. Sequi, G.; Coltro, L. Folia Med. (Naples), 49: 197-204(Mar. 1966). (In Italian).

Ninety-two persons suffering from various stages of silicosis and 20 persons with chronic cor pulmonale were given radiological, spirographic and electrocardiographic examinations with the object of detecting possible changes in the frontal area of the heart x-ray shadow, depending on the type of chronic lung disease involved, the extent of lung function impairment, and the position of the QRS axis (AQRS) in the frontal plane. The findings are discussed. No significant changes in the heart shadow were observed, other than in cases with chronic cor pulmonale. (auth) (Occup. Safety and Health Abstr.)

36670 CONSTRUCTION OF HUMAN COUNTERS, AND THE FUTURE SUBJECTS OF STUDY FOR WHOLE-BODY RADIOACTIVITY MEASURING APPARATUS. Yoshizawa, Yasuo (Tokyo Univ.). Genshiryoku Kogyo, 12: No. 11, 33-8(Nov. 1966). (In Japanese).

A human counter at the Tokyo University is described. Use and design are discussed. Shielding needs, portable human counters, and plastic scintillators are considered. (TSS) (NSA of Japan)

36671 RADIATION EFFECTS FOLLOWING RADIOTHERAPY OF GYNECOLOGICAL CARCINOMAS. Schwarz, Reinhold (Univ., Rostock, Ger.). Z. Aerztl. Fortbild., 59: 529-37(May 15, 1965). (In German).

From results previously reported in the literature and the author's own results, the reactions of the external layers of skin, parametrium, the efferent ureters, the urinary bladder, the rectum, and the neck of the femur to irradiation are discussed. The frequency and chronological appearance of irradiation reactions in these organs and tissues are related to particular method of irradiation used. There is no single, unitary definition of the concept of the irradiation reaction, and classification into early and late reactions cannot always be made. Treatment of the changes caused by irradiation is generally symptomatic, because causal treatment is impossible. Prophylaxis in which localized administration of adrenocortical hormones helps to bring about some protective effect is of basic importance. The bacteriologically induced inflammatory effects associated with irradiation reactions can be controlled with antibiotics or chemotherapeutic drugs, such as nitrofuran derivatives. The author emphasizes the importance of using a treatment pattern suited to the individual patient when Ra is to be used for treatment of the urinary bladder or the rectum. The total dose to the bladder may range as high as 8000 R, but it is advisable to fractionate this dose. Probably no more than 2400 R should be given each 24 hr. (75 references) (BBB)

36672 THE LONG-TERM SURVIVAL OF MICE PROTECTED FROM 8-MeV ELECTRON IRRADIATION BY COMBINED TREATMENT WITH CYSTEAMINE, HYPOXIA, SYNGENEIC BONE MARROW, AND ANTIBIOTICS. Shewell, Jennifer; Wright, E. A. (St. Mary's Hospital Medical School, London). J. Pathol. Bacteriol., 92: 375-84(Oct. 1966).

Experiments were conducted to determine the highest dose of whole-body 8-MeV electron irradiation that mice could survive if subjected to all the known major radioprotective procedures. The methods consisted of the combined use of chemicals (injection of cysteamine before irradiation), hypoxia (in which the mice breathed nitrogen for brief periods during irradiation), antibiotic therapy (injection of penicillin and streptomycin for 30 days post-irradiation), and intravenous injection, within 24 hr of irradiation, of syngenic bone marrow cells. Because the radioprotective factor observed may change with time after irradiation, survival curves were constructed at different time-intervals after irradiation, until all the animals died. The $LD_{50/30}$ for the protected mice was 3250 rad, giving a dose-reduction factor for the combined protective treatments of 3.8. This factor for mortality persisted throughout the long-term follow-up of the surviving mice. Protection against hair greying and epilation also gave a dose reduction factor of 3.8, but the appearance of radiation cataracts did not follow the same pattern, as cataracts developed earlier in the high-dose animals than in those receiving lower doses. It was concluded that, of the long-term effects of radiation, the lens is not protected against cataract formation to the same degree as are other systems by the 4 protective treatments used. (BBB)

36673 ATMOSPHERIC OXYGEN BREATHING AND FRACTIONATION TO ENHANCE RADIATION EFFECT. Rubin, Philip (Univ. of Rochester, N. Y.). Nat. Cancer Inst. Monogr., No. 24, 93-128(Feb. 1967).

Radiobiologic and radiotherapeutic aspects of hyperoxygenation and its relation to tumor cell sensitivity are discussed. A biological model of typical cancer cells is described, illustrating the relation between oxygen diffusion and tumor necrosis. The implication for radiotherapy is that the concentration of oxygen is lower toward the center than at the periphery of the tumor, and that a dose of radiation sufficient to kill the peripheral cells may not be adequate for the more resistant inner cells. The argument of whether radiation acts indirectly on the vascular bed of tumors or directly on cancer cells is considered. Until recently, the trend in the radiobiologic literature favored the view that the vascular reaction as a cause of cell death predominated over any possible direct cellular injury under conditions of therapeutic irradiation. Experimental evidence suggests that the vascular bed decreases during a course of fractionated irradiation. The relative anoxia of certain portions of the tumor would be expected to increase. These increasingly hypoxic tumor cells would be less responsive and further add to the ineffectiveness of irradiation. The dilemma of fractionated therapy schedules may therefore be hypothesized. However, microangiographic studies in transplanted tumors in rats indicate that, if an effective daily dose is delivered, the microcirculation does not involute as rapidly as the parenchyma. Clinical data on the oxygen tension in normal and tumor tissue, and correlation of these changes with responses during irradiation are also reported. (BBB)

36674 CHEWING TOBACCO AND RADIOIODINE. McCall, Mary S.; Timm, Lucille; Frenkel, Eugene P. (Veterans Administration Hospital, Dallas). Lancet, 1: 902(Apr. 22, 1967).

An unusual case of extensive loss of administered ^{131}I through expectorated saliva is reported. During the evaluation of a patient with suspected metastatic thyroid carcinoma, routine total 72-hr urinary ^{131}I recovery findings failed to account for a large proportion of the administered dose. This presumed retention was incompatible with the results of scintiscanning. Repeat studies revealed that 24% of the ^{131}I dose was present in the sputum. Salivary iodine concentration is well known, so that the use of chewing tobacco poses a clinical problem in diagnostic studies with radioiodine. (TSS) (BBB)

36675 NO KILOVOLTAGE DILEMMA. Buchholz, Robert E. (Wright-Patterson Air Force Base, Ohio). Oral Surg., Oral Med., Oral Pathol., 23: 459-61(Apr. 1967).

The influence of the x-ray tube voltage on the radiation exposure of patients in diagnostic dental radiology is examined. It is suggested that the sum of primary and secondary radiation doses is almost identical for exposures made at high and low kilovoltage, and that the use of high kilovoltage has been considerably overemphasized. Whereas some authors have interpreted selected studies to imply a 90% reduction in patient exposure by changing to the higher kilovoltages, the American Academy of Oral Roentgenology states as policy that the difference in patient irradiation by techniques of high or low kilovoltages is greatly overemphasized. Reasons for this divergence of opinion are discussed. It has been shown that, all other factors remaining equal, the change from low to high kilovoltage will reduce the gonadal dose by only 13%, even with a primary beam of the large diameter in general use a decade ago. Similarly, all other factors remaining unchanged, the simple change from medium-speed film to ultrafast film reduces the gonadal dose by more than 90%. Therefore, it is reasonable to expect that a 90% reduction would be noted when the factors were

changed from medium-speed film and low kilovoltage to ultra-speed film and high kilovoltage. Contrary to this conclusion, however, the expected 90% reduction is due to the change in film used rather than to the change in kilovoltage. In 1962 a study was reported in which attention was directed primarily to the effect of various cones (pointed, open-end, and shielded open-end) on the reduction of gonadal irradiation of dental patients. The data showed a difference between the various cones at low kilovoltage; a similar difference was noted between cones at high kilovoltage. The accumulated data also showed that for each cone tested the dose to the gonads was, in fact, smaller during the 65-KV exposures than during the 90-KV exposures. A study designed specifically to measure the radiation received by numerous organs of the head and neck during a 14-film periapical examination and a bitewing examination indicated that the dose with high and low kilovoltages were comparable, with few exceptions. The exceptions were at the sites of the pituitary and other more distant glands, where the 90-KV exposure resulted in a measurably higher dose than exposure at low kilovoltage. It is concluded that when all factors that are not relevant to the question of patient irradiation from exposure techniques using high and low kilovoltages are considered, the literature substantiates the thesis that the sum of primary and secondary radiation is almost identical for both. (BBB)

36676 A FOLLOW-UP STUDY OF TREATMENT OF PLANTAR WARTS WITH ULTRASOFT X RAYS. Kopp, H.; Reymann, F. (Finsen Inst. and Radium Center, Copenhagen). Acta Dermato-Venerol., 47: 46-51(1967).

In 1952, 70 patients with plantar warts were treated with 35-KV x rays. A report is given of follow-up examinations of these patients 10 to 15 yr after the radiation treatment to assess the incidence and nature of possible late effects of such treatment. The surrounding skin had been protected by lead rubber (lead equivalent of 1 mm) and the radiation field carefully adapted to the shape and size of the wart. All treatments were given as a single dose of 3000 R. Not less than 50, or 71.4%, of the 70 patients presented radiation injuries revealed by an ordinary clinical examination. Radiation-induced scars were seen in 71.4%, epidermal atrophy in 4.3%, subcutaneous atrophy in 21.4%, hyperkeratosis in 42.9%, teleangiectasia in 2.9%, ulcerations in 2.9%, and subjective complaints in 14.3%. The cicatrices were very characteristic, with a circular shape corresponding to the radiation field. The subcutaneous atrophy was often quite deep. In the many cases with hyperkeratosis, it was clearly delineated and gave rise most frequently to subjective complaints in the form of tenderness on strain. The cicatrices observed did not occur in any particular localization. Twenty cicatrices (6 of which were atrophic) were found under the forefoot, while 23 (8 atrophic) were found under the heel, and 7 cicatrices (4 atrophic) were localized in the skin regions other than the usual points of pressure. The incidence of radiation injuries is considered remarkably high and the results should have consequences for future treatment of plantar warts, namely that it is inadvisable to treat plantar warts with radiation doses such as those reported here. (BBB)

36677 REPARATIVE PLASTIC OPERATIONS IN MUTILATIONS OF LOWER LIP. Musio, L.; Donati, L.; Taveggia, F. (Univ., Milan). Minerva Chir., 21: 298-315(Apr. 30, 1966). (In Italian).

Injury to the lower lip by irradiation or surgical treatment of cancer of the lip, and its repair by plastic surgery, is described. Such injury occurred as a result of treatment of the cancer with interstitial Ra, contact therapy with radioisotopes, conventional x ray therapy, and soft x ray therapy. With more advanced methods of irradiation of lip cancer, fewer residual effects requiring repair by surgery are being observed. Numerous illustrations are provided showing the extent of the radiation injury before surgery and the final effect after plastic repair, sometimes necessitating skin grafting. Usually, loss of less than $\frac{1}{3}$ of the lip by radiation necrosis and scarring can be corrected without resorting to grafting. For more extensive loss of lip tissue, skin flaps from the chin or cheek region can be rotated and sutured to the lip defect. Details of the surgical techniques are shown. (BBB)

36678 EYEBURN DAMAGE CALCULATION FOR AN EXOATMOSPHERIC NUCLEAR EVENT. Mayer, Harris L.; Richey, Frances (Plesset Associates Inc., Santa Monica, Calif.). J. Opt. Soc. Amer., 54: 678-83(May 1964).

Calculations were carried out to explore the mechanisms of heat deposition and dissipation in the retina during nuclear tests. Threshold range for eyeburn damage was determined. Since a hazard to the eyesight of an unprotected observer may exist from the prompt visible flash caused by a high altitude or exoatmospheric nuclear event, the possible risk of eyeburn damage for resident populations of Pacific Islands from the nuclear test had to be determined. A major difficulty in the calculation arose from the fact that, while the spectral distribution of visible light from the bomb was simple to compute, the total visible energy emitted was not. Only an insignificant fraction of the total energy release of a nuclear explosion appears in the visible portion of the spectrum, whereas most calculations have been concerned with the total radiant energy released. Calculations indicated that about 10^{-6} of the total bomb yield would be within the visible range. In addition to a general discussion of the problem, estimates are given of the source strength in the visible spectrum from a weapon in the megaton range, the incident energy per unit area at 1000-Km distance, the energy absorption, and temperature rise, as well as the effect of ocular chromatic aberration on the reduction of energy density and therefore damage in the absorption layer of the retina. It was concluded that at most a 10°C rise in temperature, lasting for less than a millisecond, would result under the conditions assumed; this would not be sufficient to cause eye damage. (BBB)

36679 INFLUENCE OF THE INTERVAL BETWEEN INTRAPERITONEAL ADMINISTRATION OF CYSTAMINE AND IRRADIATION ON THE RADIO OF PROTECTED TO UNPROTECTED BLOOD-FORMING CELLS. Juraskova, V.; Tkadlecek, L.; Drasil, V. (Biophysical Inst., Brno. VLVDU JEP, Hradec Kralove, Czechoslovakia). Cesk. Fysiol., 15: 134-5(Feb. 1966). (In Czech).

Cystamine was injected into mice 5, 20, or 50 minutes before irradiation with 420 to 960 R. Best results were obtained with administration 5 minutes before irradiation. The experiments were repeated with cystamine administration 3, 5, or 8 minutes before irradiation with 350 to 650 R. Here again the best protection was obtained when cystamine was given 5 minutes before irradiation. (JPRS)

36680 IMPROVED IN VITRO SURVIVAL OF NORMAL, FUNCTIONAL SPLEEN CELLS. Mohit, Behzad; Sato, Gordon H. (Brandeis Univ., Waltham, Mass.). Science, 157: 449-51 (July 28, 1967).

An enrichment method for improving the viability of monolayers of normal mouse spleen cells is described. The cells were capable of saving lethally x irradiated recipient mice from death, presumably by proliferating and differentiating into mature blood cells. (auth)

36681 RADIATION PROTECTION AND METHEMOGLOBIN FORMATION RELATED TO THE METABOLISM OF p-AMINOPROPIOPHENONE. Downey, Ronald Lester. Bloomington, Ind., Indiana Univ., 1966. 141p.

Thesis.

In correlative studies of methemoglobin formation and radiation protection it was found that protection by p-aminopropiophenone was related to methemoglobin formation; agents other than p-aminopropiophenone that induced methemoglobinemia (for example, p-aminovalerylphenone and nitrosobenzene) also protected irradiated mice; and that the methemoglobin level did not accurately reflect the degree of desensitization to radiation due to these agents. Isonicotinic acid hydrazide blocked methemoglobin formation by p-aminopropiophenone and decreased the effectiveness of this compound as a radioprotective agent. Isonicotinic acid hydrazide evidently reduced the formation of p-hydroxylaminopropiophenone that is the functional metabolite of p-aminopropiophenone responsible for both methemoglobinemia and radiation protection. In view of the marked effectiveness of p-hydroxylaminopropiophenone as a chemoprotector it was suggested that at least part of the effects of this compound in reducing radiation sensitivity were mediated by a biological mechanism other than the induction of hypoxia. (Dissertation Abstr.)

36682 CONFERENCE ON RADIOBIOLOGY AND RADIOTHERAPY, HELD AT COLORADO SPRINGS, COLORADO, NOVEMBER 1, 2, AND 3, 1965. del Regato, J. A. (ed.). Nat. Cancer Inst. Monogr., No. 24, 1-289(Feb. 1967). (CONF-651143).

Various aspects of radiobiological research, clinical projects, technological developments, and clinical parameters in radiotherapy are discussed. Topics included are as follows: analysis and determination of variables for optimum dose distribution in moving field therapy; cell cloning experiments as models for radiotherapy; cellular radiosensitivity and tumor curability; comparative therapeutic efficacy of high-LET versus low-LET radiations; implications of cyclic fluctuations in radiosensitivity; kinetics of cancer kill by chemotherapeutic agents in vivo; model system for examining the action of antineoplastic drugs at the cellular level; nuclear factors in radiosensitivity; recovery processes in irradiated mouse L cells; statistical methods in radiotherapy; theoretical consideration of dose fractionation on effectiveness of radiotherapy; time-dose fractionation relationships in radiotherapy; uses of oxygen and dose fractionation to enhance radiation effects; and uses of heavy charged particles in cancer therapy. (B.H.S.)

Radiation Effects on Animals

Refer also to abstracts 36485, 36495, 36519, 36534, 36539, 36549, 36554, 36635, 36640, 36654, 36663, 36679, 36680, and 36682.

36683 (ABCC-TR-0-66) BIBLIOGRAPHY OF PUBLISHED PAPERS OF THE ATOMIC BOMB CASUALTY COMMISSION. (Atomic Bomb Casualty Comission, Hiroshima and Nagasaki (Japan)). 1966. Contract AT(49-1)-Gen-72. 7p. Dep. CFSTI.

Thirty-four references are given to papers on effects of atomic bombs on persons exposed at Hiroshima and Nagasaki. (W.E.B.)

36684 (AD-651181) PATHOLOGICAL EFFECTS OF THYROID IRRADIATION. (Federal Radiation Council, Washington, D. C.). July 1962. Revised Dec. 1966. 13p. CFSTI.

Therapeutic doses of x rays to the thyroid region of children have been followed after some years by the development of thyroid neoplasms. Whereas the percent of cases of malignant neoplasms is small, the proportion of persons irradiated who develop nodular thyroid disease can be extremely high. The incidence of radiation-induced thyroid disease is strongly dose dependent above 100 rads (thyroid dose). The shape of the response curve below 100 rads is unknown. X rays are probably as effective if not more so than iodine-131 in producing thyroid lesions for equal, average absorbed doses delivered to the gland at similar rates. An apparent greater effectiveness of x irradiation may be due to the higher dose rate used. Whereas it was formerly believed that the induction of thyroid tumors was enhanced by irradiation of tissues other than the thyroid itself, it now seems possible to explain variability in tumor induction in children on the basis of whether or not the gland was in the primary x-ray beam. Radioactive iodine in amounts sufficient to deliver several hundred rads to the thyroid of the infant or young child has been shown to produce a high incidence of thyroid nodules. Radioactive iodine has been shown to be carcinogenic in some animals. No case of thyroid cancer clearly ascribable to it has been reported in man. (TAB)

36685 (BNWL-SA-1156) INTESTINAL AND GONADAL INJURY AFTER EXPOSURE TO FISSION NEUTRONS. Sullivan, Maurice F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1966]. Contract AT(45-1)-1830. 15p. (CONF-670305-7). Dep. CFSTI.

From Symposium on Biological Interpretation of Dose from Acceleration Produced Radiation, Berkeley, Calif.

The vulnerability of the gastrointestinal tract and the gonads of rats to fission neutrons was studied. The rats were irradiated at doses between 150 and 310 rad. Intestinal injury was determined by measuring the rate of excretion of intravenously injected ^{131}I-labeled polyvinylpyrrolidinone (PVP). The leakage of PVP into the intestine was proportional to the neutron dose and was decreased by preirradiation treatment of the rats with cysteine (1.0g/kg). An RBE of 3.0 was determined for fission neutrons based on PVP data; this was about the same as the RBE that was determined by mortality. The time of death indicated that hematopoietic injury was a major cause of death. The rats that survived acute intestinal injury were mated to obtain additional information on fecundity. All males surviving the irradiation were sterile three months after exposure; females produced litters one month after exposure at all dosage levels. On subsequent matings, males exposed to the lowest dose became fecund; females gave birth to litters that decreased in size as the neutron dose increased. In males that were exposed to the higher doses, the testes were still atrophic at the conclusion of the study. Results demonstrated the sensitivity of both the gonads and intestines of rats to neutron irradiation and indicated the usefulness of specific indicators for measuring injury from neutron irradiation. (B.H.S.)

36686 (NP-16513) POVEDENIE ZHIVYKH ORGANIZMOV V POLYAKH IZLUCHENII. (Behaviour of Living Organisms in Radiation Fields). Darenskaya, N. G.; Pravdina, G. M.; Khrushchev, V. G. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1965. 19p. (In Russian). Dep.

The methods used to evaluate the reactions of different animal species to ionizing radiation in small doses under conditions of constant volume were investigated. The methods can be used for the characterization of individual sensitivities of animals to radiation. It was shown that the animals react to very small doses of radiation of the order of 1 to 2 R during exposure of the head and the stomach and 0.001 and 0.05 R with whole-body exposure. The ability of the different species (mouse, rat, guinea pig, and monkeys) to locate the position of the radiation source and to avoid water troughs placed in the gamma radiation zone was apparent. The threshold effects of the dose, to which the animals reacted during whole-body irradiation, were determined. For guinea pigs the threshold dose was 0.0017 R/sec, for mice it was 0.0023 R/sec, and for rats it was 0.0127 R/sec. The comparison of the threshold dose to which the different species reacted under the experimental condition made it possible to arrange them according to their sensitivity; the most sensitive were guinea pigs, then mice, and the least sensitive were rats. (tr-auth)

36687 (ORO-1749-17) STUDY OF THE EFFECTS OF RADIATION ON HOST-PARASITE RELATIONSHIPS. Progress Report. Jones, Arthur W. (Tennessee Univ., Knoxville. Dept. of Zoology and Entomology). June 15, 1967. Contract AT(40-1)-1749. 17p. Dep. CFSTI.

Brief summaries of progress made in research investigations with the cestode, Hymenolepsis microstoma, are presented. Areas under investigation included: aging and longevity; growth patterns and immunology; genetic characteristics; mechanism of resistance to x radiation; radiation damage during growth; and recovery of cestodes from radiation effects. (B.H.S.)

36688 (N-67-18939) CHANGES IN NERVE CELLS AS A RESULT OF THE ACTION OF IONIZING RADIATION. Smirnov, A. D. Translated from Doki. Akad. Nauk SSSR, 131: 1171-3 (1960). 11p. (NASA-TT-F-10723). CFSTI.

Results are reported from a histomorphological analysis of various central nervous system structures from x-irradiated (500 R) dogs. Three figures show histological changes in various neural tissues caused by irradiation. The mechanisms of these changes are discussed. The conclusion drawn from this study was that histomorphological changes in the nervous system reflect its sensitivity to ionizing radiation. Injury to neurons of the vasomotor reflex arc should be considered relative to the general pathogenesis of radiation sickness and the hemorrhagic syndrome as reflecting disruption of vascular wall trophics. (CFSTI)

36689 INVESTIGATION ON BIOLOGICAL RADIATION PROTECTION. PART 78. THE ACTIVITY OF PHOSPHOENOLPYRUVATE-CARBOXYKINASE AND PYRUVATE KINASE IN MOUSE LIVER AFTER WHOLE-BODY IRRADIATION. A REPORT ON THE DISTURBANCE OF CARBOHYDRATE METABOLISM AFTER IRRADIATION. Berndt, Juergen; Ulbrich, Ortrun (Univ., Freiburg i. B.). Strahlentherapie, 133: 288-95(June 1967). (In German).

The activity of pyruvate kinase and phosphopyruvate carboxylase (phosphoenolpyruvate-carboxykinase) in the cytoplasm of liver tissue of whole-body x-irradiated white male mice (690 R) was measured over a 12-day period. In mice that were fed, the activity of pyruvate kinase decreased and the activity of phosphopyruvate carboxylase underwent an increase; phosphopyruvate carboxylase activity did not change from day three to day 12. In animals that were starved for 24 hours, the pyruvate kinase activity remained about normal for nine days and then increased; phosphopyruvate carboxylase activity decreased from day six to day 12. The significance of the variations in the activity of these pacemaker enzymes for gluconeogenesis and gluclose after whole-body irradiation are discussed. (B.H.S.)

36690 BASAL CELL CARCINOMA ON X-RAY BURDENED SKIN. Ehring, Franz; Honda, Mitsuyoshie (Westfaelische Vereins fuer Krebs- und Lupusbekaempfung, Munster, Ger.). Strahlentherapie, 133: 198-207(June 1967). (In German).

Among 2005 patients with basal cell carcinomas, 106 patients had tumors that developed on x-irradiated skin. Radiotherapy had been done in most cases because of chronically inflammed dermatoses, almost never because of tumors. The radiation dose was usually high, the interval until tumor appearance was long but did not depend upon the radiation dose. Four characteristic cases are described in detail. (S.M.H.)

36691 CHANGES IN THE ELEMENTS OF THE BLOOD, THE SERUM PROTEINS, AS WELL AS STERNUM MARROW DURING AND AFTER X-IRRADIATION OF THE THORACIC WALL FOR MAMMARY CARCINOMAS. Spoljar, Milan; Zunter, Franjo; Kubovic, Milan; Premuzic, Branko; Konstantinovic, Miodrag (Medical Faculty, Zagreb). Strahlentherapie, 133: 238-44(June 1967). (In German).

Changes in the bone marrow of the sternum, such as partial or complete disappearance of the hematopoietic elements, were evident after administration of a focal dose of 3000 R or more within a period of 3 to 4 weeks. Irradiation of the thoracic wall with this dose does not result in significant changes of the peripheral blood elements. There is no significant change in the ratio of albumins and globulins in the serum prior to as well as after irradiation. The albumins are decreased in favor of the globulins. Deviations from the values obtained prior to or 6 months after irradiation were observed in some globulin fractions immediately after irradiation. (auth)

36692 INVESTIGATIONS OF THE BEHAVIOR OF DOUBLE-NUCLEI LYMPHOCYTES AFTER RADIATION TREATMENT.

Hartweg, Helmut; Schmitt, Hans Erich; Renner, Karlheinz (Univ., Basel). Strahlentherapie, 133: 245-51(June 1967). (In German).

An increase of lymphocytes with two nuclei after radiation exposure is reported. This fact was tested in 40 patients after therapeutic partial body irradiation. An increase of the relative value of lymphocytes with two nuclei after irradiation could be confirmed. The absolute value of the two-nuclei lymphocytes remained constant after radiation exposure. In the interpretation of previous observations, it was seen that the apparent increase in two-nuclei lymphocytes is due only to the response of the one-nucleus lymphocytes, the amount of those decreases significantly even after small radiation doses. Since there is a difference in radiation sensitivity between one-nucleus and two-nuclei lymphocytes are of lymphocytic origin. They could probably be monocytic types. (auth)

36693 COMBINED EFFECTS OF VEGETATIVE POISONS AND PENETRATING RADIATION ON VARIOUS IMMUNOBIOLOGICAL FUNCTIONS OF THE RECTICULO-ENDOTHELIAL SYSTEM. Stepanyan, E. D.; Petrosyan, R. A.; Grigorenko, L. P. (Inst. of Physiology, Kiev. Lab. of Radiation Genetics, Erevan). Biol. Zh. Arm., 20: 60-7(Jan. 1967). (In Russian).

Ionizing radiation changes the phagocytic activity of the reticulo-endothelial system of rabbits and white mice in two stages: in the first there is a short duration depression and then a very prolonged stimulation. Antibody formation in the irradiated rabbits as a rule is reduced and during distinct and joint use of vegetative poisons with radiation is often changed irregularly. The phagocytosis in test animals under individual application of atropine, ergotoxine, and pilocarpine is disturbed as well as during their joint utilization with radiation. With the introduction of inactive animal adrenaline the absorption is inhibited, and during its combination with irradiation it is increased. The protective effect of pilocarpine depends on its dosage, the irradiation dose, and on the time and sequence of its effect. Injections of ergotoxine and particularly pilocarpine sharply increase the radiosensitivity of the organism, a phenomenon not observed with the introduction of adrenaline or atropine. Parallel with the change of the tone of the sympathetic or parasympathetic divisions of the vegetative nervous system, the absorbing capacity of the reticulo-endothelial system and the general radiosensitivity of the organism are altered. (tr-auth)

36694 EFFECT OF INCREASED ENDOGENOUS GONADOTROPHIN ON TESTES OF IRRADIATED IMMATURE AND MATURE RATS. Binhammer, R. T. (Univ. of Cincinnati). Radiat. Res., 30: 676-86(Apr. 1967).

Holtzman male rats were irradiated at 30, 60, 90, or 150 days of age with a lethal dose of whole-body irradiation and subsequently parabiosed to normal or castrated partners. Pairs were killed after 20 days, and testes and ventral prostates were weighed; changes in weights of ventral prostates were interpreted as due to altered secretion of androgen from interstitial cells of the testes. Irradiation caused a significant reduction in weights of the testes and ventral prostates in all age groups. The interstitial tissue of the irradiated testes was capable of responding to increased endogenous gonadotrophin secreted by the castrated partner's pituitary, but not to the same extent as in the nonirradiated animal. Effects of irradiation and repair by pairing with a castrated partner were more marked in the 30-day-old animals than in other age groups. Histologic study was made of the testes in the 30-day group. The tubular epithelium of the gonadotrophin-stimulated, irradiated testes was, in most instances, stratified and consisted mainly of spermatids, and the interstitial cells were large with abundant cytoplasm; in contrast, the nonstimulated, irradiated testes exhibited tubules with a single layer of epithelial cells and interstitial cells which were small and contained pyknotic nuclei. (auth)

36695 STUDIES ON THE HEMATOPOIETIC STEM CELL. I. NATURE OF THE COLONY-FORMING CELL. Nakao, Kiku; Takaku, Fumimaro (Tokyo Univ.). Nippon Ketsueki Gakkai Zasshi, 29: 1-7(Feb, 1966). (In Japanese).

The colony-forming cell appearing in the spleen of mice that had received x irradiation and isologous bone marrow transplantation was studied in female dd-strain mice. Radioiron incorporation into the recipient mouse spleen was measured as an index of the formation of the colony. Incorporation of the ^{59}Fe into the spleen of the recipient mouse was significantly increased on the 5th day after transplantation as compared with that in the control irradiated mouse. The increase was marked on the 7th day. Therefore, the 7th day after the irradiation and the transplantation was chosen as the day of sacrifice of the recipient mice. Iron-59 was injected intravenously 6 hours before the sacrifice. Injection of isologous bone marrow cells collected from the transfusion-induced polycythemic mice in which precursors of erythroid cells were absent resulted in the formation of colonies in the spleen of the recipient mice as well as with the injection of normal bone marrow cells. Results of this experiment are considered to indicate that cells forming colonies of red cell precursors are not differentiated erythroblasts but are undifferentiated stem cells. Injection of isologous lymph-node cells and thymus cells showed no formation of colonies in recipient mice, indicating the absence of the colony forming cell among those cells. Existence of the colony-forming cell in the peripheral blood of the mouse was indicated by our present studies. When mice were made polycythemic by being transfused with isologous red cells after x irradiation and bone marrow transplantation, no incorporation of the radioiron into the spleen of the recipient polycythemic mouse was observed on the 7th day. Dependency of the colony-forming cell on erythropoietin for its development to the erythroblast was suggested by the present experiment. (NSA of Japan)

36696 AGE DEPENDENCE OF MORPHOLOGICAL CHANGES OF BONE-MARROW IN RATS FOLLOWING THE EFFECT OF X RADIATION. Cholin, V. V. (Institut fuer Aerztliche Fortbidung, Leningrad). Radiobiol.-Radiother., 7: 755-64(1966). (In German).

The dependence of radiation injury of the bone marrow on age in rats was examined at different intervals after irradiation at doses of 50 and 200 R. Minimum to relatively trivial symptoms of a general radiation syndrome were observed. It was found that the changes of the bone marrow in all animals were characterized by the development of typical stages of affection. Four stages were recognized and were as follows: A beginning destruction of a certain part of the free cell constituents that was accompanied by the simultaneous removal from the organ; a succeeding atrophy of the organ that was attributed to cell loss without perceptible destruction of the cells; a regenerative phase; and a late dystrophic change. The beginning of cell destruction accelerated the processes of maturation and to a more or less large extent preceded it. The most obvious stages appeared after a radiation dose of 200 R. The dose of 200 R apparently was the lower limit and caused trivial damage in mature rats. In growing, not yet mature rats, however, the dose led to the development of clearly marked stages of injury. The bone marrow of one-month-old animals was most severely damaged; the damage appeared early and there was numerous development of initial cell destructions. The beginning atrophy of the organ was due to the suppression of hematopoiesis. In the animals 25 to 30 days of age irradiation provoked retarded development of initial cell destruction. Simultaneously, the relatively frequent development of late dystrophic changes was characteristic of these animals and in the beginning processes of reparation they commenced relatively quickly. The cells of the erythropoietic branch of blood formation and the cells of granulopoiesis underwent obvious and significant changes. The suppression and regeneration of red blood cell formation occurred on an average relatively quicker than that of normal granulocytes. (auth)

36697 RESULTS OF TREATMENT OF 54 OVARIAN TUMOURS PRODUCING FOLLICLE STIMULATING HORMONE WITH AN OBSERVATION PERIOD TO 5-18 YEARS. Kielbinska, S.; Medvey, W.; Tarlowska, L.; Strzeszynski, J. (Onkologische Instituts, Warsaw. Onkologische Institut, Krakow). Radiobiol-Radiother., 7: 733-8(1966). (In German).

Among 54 patients treated and observed for ovarian tumors producing follicle stimulating hormone the 5-yr survival without symptoms was 57%. Thirteen percent lived more than five years with tumorous symptoms. The success of the treatment depended on the tumor stage in the first operation. Only 3 out of 12 patients with signs of malignancy were healed. This shows that the histological picture for these tumors may be of prognostical value. Postoperative radiation therapy apparently improves the results. Even for extended metastases survival times of several years may be achieved by radiotherapy. (auth)

36698 COMMUNICATION ON A RARE IRRADIATION EFFECT OF A BONE METASTASIS OF THE FOOT. Oei, L. Ong; Roth, A. (Humboldt Univ., Berlin). Radiobiol.-Radiother., 7: 749-53(1966). (In German).

An unusual radiation effect on an osteolytic hemangio-endothelioma metastasis of the second left metatarsus is reported. After telecobalt irradiation with a dose of 3900 R to the tumorous area, the bone nearly completely regenerated. An explanation of this phenomenon was attempted. (auth)

36699 SERUM PROTEIN PICTURE OF THE RAT FOLLOWING WHOLE-BODY X IRRADIATION AND ITS RELATION TO PATHOHISTOLOGICAL CHANGES OF LIVER AND KIDNEY. Roesler, B.; Lahl, R. (Medizinische Akademie, Magdeburg, Ger.). Radiobiol.-Radiother., 7: 765-84(1966). (In German).

Different types of dysproteinemia occurred in the serum protein picture of the rat following whole-body irradiation with 800, 900, and 1000 R, respectively. More severe deviations in the rate of albumin and γ-globulin decrease were demonstrated; especially α_1-, as well as α_2- and β_1-globulin, fractions proved to be variable for the single animals. In starch-gel electropherograms post-

albumins distinguished themselves by some special forms. Pathohistological findings of the liver in terms of necroses and fatty degenerations of cells were radiation-unspecific. For a small part, animals with severe tubular renal changes were observed at a dose between 800 and 1000 R in opposition to the data in literature; in accordance with more recent examinations a primary damage of the tubular apparatus was thought to be probable. Certain relations may be demonstrated between serum protein picture and pathohistological changes in liver and kidney. In certain stages of a radiation syndrome, albumin decrease seemed to take a conformable course with the extent of liver damage. In several cases unusually low serum protein values occurred with the pseudocystic enlargement of the renal tubules with hyaline-droppy demixture and hyaline cylinders. An α_1-double fraction did not exist in these rats. (auth)

36700 THE COURSE OF ACUTE RADIATION SICKNESS OF GROWING RATS IN DEPENDENCE ON RADIATION QUALITY. Cholin, V. V. (Leningrad Medical Inst.). Radiobiol.-Radiother., 8: No. 1, 121-8(1967). (In German).

The peculiarities in the course of the acute radiation sickness in 2,634 rats of different age were investigated in dependence on radiation quality. The animals were whole-body irradiated with doses of 200, 500, 1000, and 2000 R. Under the effect of soft x rays (Δ0.25 mm Cu) there was a regular decrease of the severity of radiation sickness in all groups of age compared with harder radiation (Δ1.1 mm Cu). The decrease of severity degree was more pronounced for the mature rats, less marked for newborn rats. In the range of lethal doses however, the interval of dying-dates for rats irradiated with radiation of different quality increased the younger animals were. The usual idea that the decrease of the biological effect for irradiation with soft compared with hard radiation is the result of the peculiarities of the spatial dose distribution does not account for all the facts found. (auth)

36701 ON THE VARIATION OF LD-50 IN TIME AFTER 14.1 MeV FAST NEUTRON AND 180 kVp X-RAY IRRADIATION FOR YOUNG AND ADULT MICE. Yamamoto, Osamu (Hiroshima Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 26: 1361-71(Jan. 1967). (In Japanese).

Four week and 8 week old mice were exposed to 14.1 MeV fast neutrons and 180 kVp x rays to demonstrate post-irradiation changes in young and adult animals. The LD 50/30 has been generally used to evaluate relative biological effectiveness of radiation. In addition to central nervous system death, intestinal death, and bone marrow death are acute effects. LD 50/30 includes both intestinal death and the bone marrow death, and does not indicate the effect of each separately when each appears by different degrees. LD 50/9 was used for observation of intestinal death. Data are reported on mortality, body weight change, and the RBE value observed following irradiation. Though it is difficult to establish clearly the RBE value for bone marrow injury, it was more marked in the adult than in the young animals on comparison of RBE values for LD 50/9 and LD 50/30. In the case of fast neutrons and x irradiation, the ratio of the young to adult is about 0.90 for LD 50/9. This ratio for LD 50/30 decreases further in the case of neutron irradiation. In the case of x rays it is on the contrary. The decrease in absorption dose in bone marrow is responsible, since the effect on bone is smaller in the young than in the adult animal. (NSA of Japan)

36702 RNA-ASE ACTIVITY IN THE LUNGS OF IRRADIATED MICE AFTER INFECTION OF THE ANIMALS WITH THE VIRUS OF INFLUENZA. Sklyanskaya, E. I.; Peterson, O. P. (Inst. of Virology, Moscow). Radiobiologiya, 7: 87-9(1967). (In Russian).

Irradiation of mice with x rays at a dose of 400 R increased the acid RNA-ase activity in their lungs 24 hrs after irradiation by 20 to 30% when compared with nonirradiated controls. Infection of the irradiated animals with influenza virus increased the activity of acid RNA-ase in the lungs still further. The ratio of RNA-ase activity in the lungs of irradiated and infected animals to that in the lungs of irradiated, but not infected animals 10 min, 3 hrs, 24 hrs, and 48 hrs after infection was 1.2, 1.3, >2, and 1.3 to 1.0, respectively. It dropped to 0.87 : 1.0 4 hrs after infection. Infection of nonirradiated mice lowered the RNA-ase activity vs controls until the 48th hr after infection, at which an increase corresponding to a ratio of 1.18 : 1.0 was observed. One may assume that activation of RNA-ase, which leads to a more intensive destruction of cell polynucleotides and polysomes, is one reason for the lowered resistance of mice to influenza after irradiation with x rays. (JPRS)

36703 TEMPERATURE DEPENDENCE OF IONIZING RADIATION EFFECT ON DRY PREPARATIONS OF TWO MELANOPHORE-STIMULATING HORMONES. Bartell, Clelmer K.; Fluke, Donald J. (Duke Univ., Durham, N. C. Florida State Univ., Tallahassee). Radiat. Res., 30: 811-24(Apr. 1967).

Dry preparations of melanophore-stimulating hormone (α-MSH) and of fiddler crab eyestalk extracts were irradiated with fast electrons. The irradiations were carried out in a vacuum and at absolute temperatures from 90 to 420°K. The direct action of the radiation on melanin-dispersing activity in the chromatophores of appropriate assay animals can be interpreted according to target theory and also in terms of Arrhenius activation energies for yield in relation to temperature. At temperatures around 300°K the radiation sensitivity of α-MSH corresponds by target theory to a molecular mass of 1100 g/mole. For the crab hormone the radiation-sensitive mass is about 3750 g/mole from irradiations at that temperature. Results at various temperatures for α-MSH indicate only roughly an activation energy between 350 and 600 cal/mole. For the crab hormone two activation energies are evident, one at 200 cal/mole and the other at around 3300 cal/mole. The patterns of activation energies are reasonably distinct from those evident in such work with enzymes. (auth)

36704 IRREPARABLE DAMAGE FOLLOWING X-IRRADIATION OF THE FETAL MOUSE. Christensen, Gerald M.; Jackson, Kenneth L. (Univ. of Washington, Seattle). Radiat. Res., 30: 850-4(Apr. 1967).

The $LD_{50(30)}$ of 8-week-old Swiss–Webster mice which had received a 150 R dose of x radiation in utero at the fourteenth to fifteenth day of gestation was determined and compared with the corresponding value in unexposed control mice born at the same time under identical conditions. The $LD_{50(30)}$ for in utero exposed females was 580 R, compared to 625 R for controls, indicating a residual, nonrepaired damage of 45 R, or 30% of the initial dose. The $LD_{50(30)}$ for in utero exposed males was 550 R, compared to 630 R for the control animals, which indicates an irreparable damage equivalent to 80 R, or 53% of the fetal dose. Mean survival time of decedents within all groups ranged between 12.3 and 13.5 days. It is concluded that the fetal animal, as compared to the mature animal, is considerably more sensitive in terms of irreparable radiation damage. The correspondence in mean survival times of the irradiated adult groups suggests that the differences in the $LD_{50(30)}$ reflect an increase in radiation sensitivity of the hematopoietic tissue in animals exposed in utero. (auth)

36705 PHOTOALLERGY IN DERMATOLOGY. Kobori, T.; Araki, H. (Tokyo Teishin Hospital). J. Asthma Res., 3: 213-15(Mar. 1966).

The effect of uv radiation on human skin was studied, including an estimation of the minimal erythema dose (MED), in 212 subjects and the interactions of uv with photosensitizing drugs in patients with photoallergies. A Xe lamp was used, with a uv29 filter interposed between skin and light source to eliminate uv rays shorter than 2500 Å. The back or flexural aspect of the upper arm of the patients was chosen for the test site. Estimation of MED carried out in normal subjects and patients with skin diseases showed that the MED of males was lower than that of females. There was no significant relation between MED and age. Among the patients with various photosensitivity dermatitides, the patients with polymorphous light eruption, of which the cause was unknown, and the patients taking griseofluvin showed a low MED in most cases. The MED of patients with hemoangioma, nevus, and alopecia areata was within the normal value. In photopatch tests, test substances were applied on 2 separate sites 24 to 48 hr prior to uv irradiation. One of these sites and another (control) site were then exposed to uv light with 1 MED or a suberythema dose. Phototests were also done after ingestion of drugs. It was found that sodium cyclohexylsulfamate, a widely used artificial sweetening agent, may act as a photoallergic agent. In a typical case with photosensitive dermatitis due to this sweetening agent, the patient had recurrent severe photodermatitis on the exposed area past 2 yr. No other drugs were taken. The photopatch test with sodium cyclohexylsulfamate was positive, as was the phototest following its ingestion. The skin condition became worse after exposure to the sunlight and improved rapidly when this material was no longer ingested. Some cases were also sensitive to sulfonamides, chemically similar agents. Six cases with photosensitive dermatitis due to griseofulvin were noted. Two cases showed positive photo cross-reactions to penicillin. There were 4 cases showing a cross-reaction between griseofulvin and other antibiotics such as fradiomycin, kanamycin, and streptomycin. Benzothiadiazine derivatives caused photosensitive dermatitis followed by characteristic leukomelanosis. (BBB)

36706 QUANTITATIVE RECOVERY CHARACTERISTICS AFTER GENERAL AND LOCAL γ-IRRADIATION OF RATS. Domshlak, M. P.; Darenskaya, N. G.; Gorlov, V. G. (Inst. of Biophysics, Moscow). Radiobiologiya, 7: 59-62(1967). (In Russian).

Rats were subjected to general irradiation with γ rays at a dose of 300 R or local irradiation of the head with 1800 R, which produced the same lethality as general irradiation with 300 R. As a

criterion for the quantitative estimation of recovery, the change in $LD_{50/30}$ on two-fold irradiation as compared with the dose corresponding to 50% survival after a single irradiation was used. Within 7, 14, or 21 days after the first irradiation (general or local), the rats were irradiated again with various determining doses (300, 450, 500, 550, 600, and 700 R) in such a manner that as a result of the total dose administered the number of animals that died varied from 0 to 100%. The values of $LD_{50/30}$ were then estimated by the method of least squares. Both after general and local irradiation, the experimental recovery curve corresponded most closely to a theoretical curve calculated on the basis of an exponential relation. (JPRS)

36707 LATE EFFECTS OF ^{3}HTDR AS A DNA LABEL ON LIVER CELL REPLICATION. Post, Joseph; Hoffman, Joseph (New York Univ. Goldwater Memorial Hospital, New York). Radiat. Res., 30: 748-58(Apr. 1967). (NYO-2778-3).

The replication kinetics of liver cells were studied in 1-day-old and in 3-week-old rats, at 3 and 5 weeks, respectively, after administration of 2 and 10 μCi of tritiated thymidine (^{3}HTDR) per gram of body weight. Estimates of the respective generation times and their component intervals were made from the changing percentages of labeled mitoses. In the younger rats, after 2 μCi/g, the rhythm of replication was disorganized. In the older rats a new rhythm was established. The generation time of the replicating diploid hepatocyte was doubled without change in either G_2 + mitosis or DNA synthesis time intervals. There was marked prolongation of the G_1 interval. At these levels of ^{3}HTDR administration no histological abnormalities were found in the liver. (auth)

36708 THE INDIRECT EFFECT OF IRRADIATION ON EMBRYONIC DEVELOPMENT. III. THE CONTRIBUTION OF OVARIAN IRRADIATION, UTERINE IRRADIATION, OVIDUCT IRRADIATION, AND ZYGOTE IRRADIATION TO FETAL MORTALITY AND GROWTH RETARDATION IN THE RAT. Brent, Robert L.; Bolden, Booker T. (Jefferson Medical Coll., Philadelphia). Radiat. Res., 30: 759-73(Apr. 1967). (NYO-2071-34).

Shielding techniques were utilized to differentiate the results of irradiating the ovary, uterus, zygote, and oviduct in the pregnant rat prior to the time of differentiation. Six-day pregnant rats administered 150 R of x radiation exhibited the same embryonic mortality and growth retardation whether or not the ovaries were shielded. Nine groups of experimental rats were irradiated on the first day of gestation. The results indicate that neither uterine nor ovarian irradiation at the 150-R dosage contributed to the resulting fetal mortality, which is obviously due to direct irradiation of the oviduct and the ova contained within it. Although it appears most likely that the primary effect is due to the direct effect of irradiating the ova, these experiments do not rule out pathological effects due to oviduct irradiation. The incidence of malformations in the embryos irradiated on the first day and after 6 days of gestation was very low. No instance of exencephaly was observed. These findings further reinforce the difficulty in applying specific teratological findings from one species to man, since there are apparently marked differences in teratological sensitivity even in the rodent category. The literature dealing with the indirect effects of irradiation on the mammalian embryo is reviewed. (M.M.B.)

36709 TREADMILL EXERCISE PERFORMANCE BY THE AGING IRRADIATED RAT. Jones, D. C.; Osborn, G. K.; Kimeldorf, D. J. (Naval Radiological Defense Lab., San Francisco). Radiat. Res., 30: 714-24(Apr. 1967).

Treadmill performance of male rats was evaluated at 6-month intervals throughout life. Irradiated groups received whole-body sublethal (30-day) or lethal-range doses of x rays (430 or 680 RADS) or fast neutrons (230 or 320 RADS) as young adults. The proportions of animals completing the task declined gradually with increasing age, then decreased markedly at 28 months in controls and at 22 months of age in irradiated groups. Terminal performance deficits appeared to be associated with approaching death, and their earlier appearance in irradiated animals with radiation-induced life-span shortening. Heart rate rose abruptly with the onset of exercise, remained relatively stable throughout the 1-hour exercise period, and returned to pre-exercise levels within a half-hour at rest. This heart-rate pattern was not markedly affected by age or by irradiation. At younger (3 months) or older (22, 28 months) ages, colonic temperature increased with the initiation of exercise, decreased or remained stable until cessation, and returned to pre-exercise levels within 15 minutes at rest. Increasing temperature throughout exercise in controls at 10 and at 16 months of age was not observed in irradiated groups, apparently as a consequence of permanent radiation-induced decrements in body weight. (auth)

36710 STATE VECTOR DESCRIPTION OF THE PROLIFERATION OF MAMMALIAN CELLS IN TISSUE CULTURE. II. EFFECTS OF SINGLE AND MULTIPLE DOSES OF IONIZING RADIATIONS. Hahn, George M.; Kallman, Robert F. (Stanford Univ., Palo Alto, Calif.). Radiat. Res., 30: 702-13(Apr. 1967).

Previously developed formalism describing the proliferation of cultured mammalian cells is extended to include effects of single and multiple doses of ionizing radiations. Specific operators are presented in matrix form; these operators permit calculation of the effects of stage-dependent radiation-induced cell killing and mitotic delay on the subsequent cellular kinetics. Calculations of surviving fractions after multiple radiation exposures are shown to be a natural extension of the theory. Values of D_0 and extrapolation numbers obtained from x-irradiated synchronized Chinese hamster cells are used to calculate response of an exponentially growing population, and good agreement with measured data is obtained. The survival of these cells after a two-dose experiment is then analyzed. It is shown that, in addition to cell killing and mitotic delay, repair of sublethal damage needs to be taken into account. Repair appears to be complete 3 to 4 hours after the conditioning dose. If cell killing, repair, and mitotic delay are included in the kinetic calculations, the theory quantitatively predicts the survival data of the two-dose experiment. (auth)

36711 RADIATION SENSITIVITY OF DIFFERENT STAGES OF DEVELOPMENT OF EPHESTIA RUCHNIELLA L. IN THE LIGHT OF THE CONCEPT OF DNA TRANSINDUCTION. Kuzin, A. M.; Yusifov, N. I. (Inst. of Biological Physics, Moscow). Radiobiologiya, 7: 3-6(1967). (In Russian).

Different phases in the development of Ephestia ruchniella L. (eggs, larvae, and pupae) were irradiated with γ rays at a rate of 700 R/min. The dose-effect curves were determined, using as a measure of the radiation effect the percentage of individuals that underwent metamorphosis into the next phase. The results indicated that the high radiation sensitivity of the DNA transinduction necessary for transmission of new information related to metamorphosis. (JPRS)

36712 DELAYED EFFECTS OF SYSTEMATIC IRRADIATION OF GROWING ANIMALS WITH IONIZING RADIATION. Fokina, T. V. (Inst. of Pediatry, Moscow). Radiobiologiya, 7: 63-6 (1967). (In Russian).

Dogs were irradiated regularly with x rays at a dose of 1 or 10 R per day from an early age (5 days or 1.5 months) until a total dose of 1890 to 3980 R was reached. Observations carried out for 3 yrs after irradiation indicated that most of the dogs that were exposed to a dose of 10 R per day developed acute disturbances of hemopoiesis long after irradiation, which led to death in the majority of cases. The principal disturbance in dogs that died 7 to 14 months after the end of irradiation was a severe anemia. The dogs that died 15 to 32 months after the end of irradiation exhibited mainly a myeloproliferative condition of the erythromyelosis type. (JPRS)

36713 CHROMOSOME SUBSTITUTION AND RADIOSENSITIVITY IN DROSOPHILA MELANOGASTER. Ratty, Frank J.; Lovellette, Edward J. (San Diego State Coll., Calif. Arizona State Univ., Tempe). Radiat. Res., 30: 825-31(Apr. 1967).

The survival of first instar random-bred, inbred, and hybrid larvae formed by reciprocal crosses, after 1200 R of acute x irradiation has been evaluated. The results show that survival of the irradiated lines is lower than that of the control larvae, while that of the inbred lines is lower in all irradiated and control groups. The lack of differences between the irradiated random and the irradiated hybrid lines is interpreted to mean that genetic variability is probably not important at this dose level and that detrimental genes in the hybrid genotypes are recessive. An interaction effect between radiation and inbreeding is noted, and it is suggested that a maternal effect could play only a minor role in the determination of radioresistance in these experiments. (auth)

36714 RESEARCH DATA ON THE STANDARDIZATION OF EMF'S IN THE SHORT- AND ULTRASHORT-WAVE RANGES. Fukalova, P. P.; Tolgskaya, M. S.; Nikogosyan, S. V.; Kitsovskaya, I. A.; Zenina, I. N. (Inst. of Industrial Hygiene and Occupational Diseases, Moscow). Gig. Tr. Prof. Zabol., No. 7, 5-9(1966). (In Russian).

In a survey of radio and television stations and establishments that process dielectrics thermally, measurements using various dosimeters showed that field intensities around short- and ultrashort-wave sources were 8 to 450 v/m and 4 to 220 v/m, respectively. The reaction speed and accuracy were studied in personnel exposed to these sources. It was concluded that the action of EMF's is aggravated by inefficient work-rest cycles that lead to shifts in various physiological reactions and the development of fatigue. To study the mechanism of the effect of EMF's, animals were exposed to 14, 88, and 69.7 Mc fields (5000 v/m intensity). Animals in the ultrashort-wave range were killed within 5 min, while those in the shortwave range died in 1 hr and 40 min. Nonthermal (no integral thermal effect such as increased body temperature) threshold intensity for the ultrashort-wave range was

150 v/m and for the shortwave range, 2250 v/m. Chronic exposure to these intensities (plus exposure to an ultrashort-wave intensity of 300 v/m) did not result in any substantial changes in body weight dynamics compared to control animals. However, a decrease in brain-stem cholinesterase activity occurred more rapidly during exposure to ultrashort waves than exposure to short waves. Both regimens decreased the excitability and weakened the inhibition process in chronically exposed rats. Such exposure also tended to depress brain biopotentials progressively. An ultrashort-wave intensity of 10 v/m and shortwave intensity of less than 50 v/m is a subthreshold irritant. Photos show the results of a cytomorphological examination of neural structures in exposed animals which revealed thickening of neural fibers, swelling and vacuolization of cell protoplasm in the thalamo-hypothalamic area and medulla oblongata, and local karyocytolysis of individual neurons. Shriveling of individual pyramid cells and individual vacuoles in neurons of the brain cortex was noted. Thus, it was found that an ultrashort-wave intensity of 150 v/m and a shortwave intensity of 2250 v/m is more than sufficient to cause physiological and morphological changes in neural structures and that the intensity of the effect depends on wave range, field intensity, and exposure duration. On the basis of these data, a permissible exposure intensity of 5 v/m is recommended for workers around ultrashort-wave sources and 20 v/m for workers around shortwave sources. (TSS) (ATD)

36715 VARIATION IN THE RESPONSE AND THRESHOLD TO ELECTRICAL EXCITATION OF X-IRRADIATED ISOLATED FROG NERVE WITH DOSE AND DOSE-RATE. Seymour, R.; Dowson, K. B. (Royal Marsden Hospital, Sutton, Eng.). Int. J. Radiat. Biol., 12: 1-11(1967).

An increased excitability (measured as a change in amplitude of monophasic sub-maximal action potentials in a humid chamber) of the isolated sciatic nerve of frog to electrical stimulation was found after a radiation dose of 100 rads of 50 kv x rays, although the effect probably proceeds increasingly from zero dose. The effect is dose-rate dependent in the sense that a minimum dose-rate of between 500 and 700 rads/min is required before the effect is obtained. The increased excitability is probably due to a lowering of the threshold of individual nerve fibres caused by a depolarization of their membranes, as demonstrated experimentally by demarcation potential measurements. The effect is either reduced or abolished completely by either increasing the external potassium or reducing the sodium concentration respectively, by stripping the epineural sheath from the nerve, or by reversal of the stimulating electrodes so that the anode lies between cathode and recording electrodes. Recovery times after irradiation to normal excitability or membrane polarization are much shorter for nerves irradiated in solution than for those irradiated in moist air. The results suggest that the cause of the increased excitability is a depolarization of the neural membrane caused by extracellular accumulation of potassium due to an influx of sodium and efflux of potassium resulting from an unspecific increase of membrane ionic permeability by irradiation. (auth)

36716 STUDIES ON THE CHANGES OF SALIVARY GLAND FUNCTION FOLLOWING TELECOBALT THERAPY OF MAXILLARY CANCER. Higashi, Tomomitsu (Kanagawa Dental Coll., Japan); Konishi, Toshio. Nippon Igaku Hoshasen Gakkai Zasshi, 26: 1519-25(Feb. 1967). (In Japanese).

An ^{131}I-function test was used to determine the effects of γ radiation on the parotid gland of man. Six patients with maxillary cancer who received 800 to 8000 R by telecobalt therapy served as subjects. The function of the irradiated parotid gland was found to be considerably lower than that of the nonirradiated parotid gland even when the dose was 300 R. It was concluded that the parotid gland was sensitive to radiation and that it should be protected during radiotherapy of malignant diseases of the mouth. (TSS) (NSA of Japan)

36717 INFLUENCE OF IONIZING RADIATIONS ON THE EARLY STAGES OF DEVELOPMENT OF LIMNAEA STAGNALIS L. Kulikov, N. V.; Timofeeva, N. A.; Lyubimova, S. A. (Inst. of Biology, Sverdlovsk, USSR). Radiobiologiya, 6: 908-12 (1966). (In Russian).

The effects of chronic irradiation upon the mollusk embryo were studied by incubating eggs of Limnaea stagnalis L. in aqueous solutions of ^{90}Sr and by single external γ irradiation from a ^{60}Co source. Disturbances of embryogenesis of this fresh-water mollusk (death of embryos, presence of morphological deformities, lag in development) during the incubation of eggs in solutions of $^{90}Sr-^{90}Y$ appear at rather high doses of the radionuclides in water (approximately 1.10^{-4} Ci/liter). The radiosensitivity of the mollusk embryos decreases substantially from the early stages of embryonic development to the later stages. The LD_{50} is 450 R in the γ irradiation of embryos at the early blastula stage; in the case of irradiation at the stage of appearance of the embryonic motor system, it increases to 900, while at the stage of the beginning of shell formation it rises to 2 kR. A single acute external γ irradiation of the embryos proved more effective than chronic irradiation by incubation of the eggs in solutions of ^{90}Sr. (JPRS)

36718 RADIOPROTECTIVE EFFECT OF CYSTEAMINE UNDER THE ACTION OF IONIZING RADIATION ON LOACH SPERM. Graevskii, E. Ya.; Faleeva, Z. N.; Flerova, N. K. (Inst. of Animal Morphology, Moscow). Radiobiologiya, 6: 886-90(1966). (In Russian).

The authors attempted to determine whether aminothiols can reduce the radiation injury to sperm, whether they provide protection from the indirect effects of radiation, and whether the protector can minimize the damage to these cells after irradiation, as aminothiols do in the case of lymphocytes, dried seeds, and other biological specimens. Roe of Misgurnus fossilis L. was subjected to 1000 and 1500 roentgen X irradiation at a dose rate of 496 roentgens/min. The radioprotector cysteamine in a 0.14 M solution in physiological saline was added to a suspension of sperm in physiological saline. Irradiation with 1000 and 1500 roentgens led to a decrease in the survival of the fish embryos to 54 and 36%, respectively, as a result of the direct action of radiation upon the cells. The addition of cysteamine before irradiation and directly after it almost entirely prevented radiation damage to the sperm at the radiation doses used. (JPRS)

36719 PRINCIPLES OF THE POSTIRRADIATION DEATH OF DIFFERENTIATING NERVE CELLS. II. INVESTIGATIONS OF NEWBORN WHITE RATS. Korogodina, Yu. V.; Dubrovina, V. M. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya, 6: 875-9(1966). (In Russian).

The dependence of interphase death of immature nerve cells upon the dose and time after irradiation, as well as the radiosensitivity of nerve cells at various levels of differentiation, were studied on five-day old rats of the Wistar and August lines. The cerebellar cortex of five-day old rats consists of heterogeneous cells with respect to radiosensitivity. In the outer, granular layer of the cortex, 90 to 93% of the cells are radiosensitive, and 7 to 10% are radioresistant; in the inner granular layer, 6 to 8% are radiosensitive, while 92 to 94% of the cells are radioresistant; all the Purkinje's cells are also radioresistant. The least mature cells of the cerebellar cortex are distinguished by the maximum radiosensitivity. Postirradiation death of such cells is not associated with pathology of cell division and occurs in the interphase, in the early periods after irradiation, against a background of inhibited mitotic activity. The survival curve for the radiosensitive portion of the population possesses a close to exponential shape, while the LD_{50} is approximately 100 R. (JPRS)

36720 DYNAMICS OF CHANGES IN THE IMMUNOLOGICAL REACTIVITY OF DOGS INJURED WITH TRITIUM OXIDE. Shal'nova, G. A.; Zhuravlev, V. F. Radiobiologiya, 6: 863-8 (1966). (In Russian).

In the light of earlier investigations, revealing a disturbance in the quantiative and qualitative composition of the autoflora of the skin and oral mucosa after a single intraperitoneal injection of various concentrations of tritium oxide in rats, investigations of the state of the immunological reactivity on dogs were conducted. Single intraperitoneal injections of tritium oxide in doses of 0.3 and 0.15 Ci/kg (total dose 400 and 430 rad) induced a severe form of acute radiation sickness, ending in the death of the injured dogs; one of the three dogs that received tritium oxide in a dose of 0.15 Ci/kg (total dose 310 rad) also died. The clinical course of radiation sickness after the injection of tritium oxide was characterized by the very early appearance and pronounced nature of the hemorrhagic syndrome, the early development of progressive lymphopenia, and the appearance of a large number of lysed white blood cells in the blood on the 21st to 30th day after the injury. The synthetic function of the liver was impaired, and hemocirculatory disorders of the kidneys developed. The immunological activity began to be impaired on the first day after the injury and was not completely restored during the 180 day observation period, in spite of apparent clinical well being of the animals. Together with the inhibition of infection-resistance of the organism, the development of autoallergic processes was detected in the injured dogs. The disturbances of the immunological reactivity detected were correlated with the clinical manifestations of radiation sickness. The degree of expression and intensity of the changes detected in the dogs were directly dependent upon the dose of the tritium oxide administered. (JPRS)

36721 SOME DATA ON THE DEPENDENCE OF THE MANIFESTATIONS OF THE HEMORRHAGIC SYNDROME IN DOGS DURING ACUTE RADIATION SICKNESS UPON THE TOPOGRAPHY OF DAMAGE TO THE PERIPHERAL NERVOUS SYS-

TEM. Lebedev, B. I. Radiobiologiya, 6: 848-50(1966). (In Russian).

The peculiarities of the topography of changes in the peripheral nervous system depending upon the predominant localization of hemorrhages during acute radiation sickness were studied on groups of dogs that died of radiation sickness, and exhibited a distinct delimitation of hemorrhages either to the organs of the thorax or to the organs of the abdominal cavity. Irradiation was performed with absolutely lethal doses of x rays, γ rays and high-energy protons. In all the animals, regardless of the localization of the hemorrhages, changes developed in the peripheral nervous system, characteriatic of acute radiation sickness in general. In the case of hemorrhages predominantly in the abdominal cavity, distinct changes were observed in the solar plexus and the lumbar spinal ganglia. In animals with hemorrhages in the organs of the thorax, primarily the stellate, upper cervical, cervical-spinal and nodular ganglia were affected. The nerve processes were more distinctly changed at the site of localization of the hemorrhages. (JPRS)

36722 HEMATOLOGICAL CHANGES IN THE COMPRESSION PHASE OF THE PRESSING SYNDROME IN IRRADIATED AND NONIRRADIATED ANIMALS. Ur'lyanov, M. I. (Central Scientific Research Inst. of Traumatology and Orthopedics, Ministry of Health, USSR). Radiobiologiya, 6: 842-3(1966). (In Russian).

The hematological changes arising during pressing of the soft tissues of the hip were studied in irradiated (x irradiation, dose-rate 11 R/min, dose 400 R) and nonirradiated dogs. Pressing was produced with a special press, applying a force of compression of 500 kg for six hours. Pressing of the soft tissues in nonirradiated animals was found to be accompanied by a progressive increase in the total number of leukocytes in the peripheral blood. The hematological changes continued to increase during the first hour after removal of the press, a tendency toward normalization being noted only on the following day. No statistically significant changes in the total leukocytes and leukocytic makeup at the beginning of compression were observed in the irradiated animals. Only an hour after removal of the press did the hematological changes approximate the changes observed in nonirradiated animals. There thus seems to be a time lag in the changes under the combined influence of irradiation and pressing of the soft tissues. Furthermore, under the combined influence, the degree of change in a number of hematological indices was smaller than with nonirradiated animals; the early reactions were not observed, and there were no reactive changes at all in the reticular stroma of the bone marrow. (JPRS)

36723 SIGNIFICANCE OF THE INTEGRAL ABSORBED DOSE IN EVALUATING THE SEVERITY OF RADIATION DAMAGE TO THE ORGANISM. Kholin, V. V. (Inst. for the Advanced Training of Physicians, Leningrad). Radiobiologiya, 6: 833-6(1966). (In Russian).

The age response of 1593 noninbred albino rats to irradiation was studied in connection with a determination of the integral absorbed dose. Rats that were: sexually mature, 25 to 30 days, 9 to 10 days, or newborn were x irradiated at doses of 200, 500, 1000, and 2000 R at a date of 80 R/min. The integral absorbed dose was determined by calculation. The rats of each age group were found to have their own fixed integral absorbed dose at which a specific percentage survival was observed. Within the limits of an equal exposure dose, the integral absorbed dose was found to decrease regularly with decreasing age of the rat. The survival rate, however, decreased with decreasing age, indicating that it is not the total absorbed dose, but age differences in the radiosensitivity of the animals that determines their survival after irradiation. The age differences in the severity of radiation sickness were not determined by the integral absorbed dose. No correlation could be detected between the size of the animals and the severity of radiation sickness. Other factors that influence the nature and the severity of radiation sickness are mentioned, such as the physical distribution of the dose, the site of irradiation, and the time factors. (JPRS)

36724 PROBLEMS OF RADIONEUROLOGY AT THE THIRD CONGRESS ON RADIATION RESEARCH. Livshits, N. N. Radiobiologiya, 6: 923-4(1966). (In Russian).

A number of problems were taken up at the Congress on problems of the effects of radiation on the nervous system. These included the effects of radiation on the neuroregulatory mechanisms and the role of the nervous system in the pathogenesis of radiation sickness; problems of the effects of irradiation at low doses; an experimental analysis of the susceptibility of fowl to x rays; changes in the bioelectric activity of portions of the cortex and subcortical formations in dogs under the influence of local x irradiation of the head; problems of the radiosensitivity of the nervous system during the prenatal period and early postnatal ontogenesis; biochemical correlations of the functional disorders induced by prenatal irradiation; and inhibition of enzyme synthesis, including glycerophosphate dehydrogenase, in the brain stem of rats subjected to irradiation of the head. Other reports dealt with an analysis of the physiological mechanisms of radiobiological response of the central nervous system at various stages of postnatal ontogenesis; species differences in the effects of x irradiation upon respiration and glycolysis of the retina in guinea pigs and rats. Also discussed were the injurious effects of radiation upon the higher nervous activity and the behavior of adult animals and the problem of discrepancies in the results of experiments of Soviet and American researchers. (JPRS)

36725 INCLUSION OF THE LIVER IN IMMUNOGENESIS DURING ACUTE RADIATION SICKNESS. Rabichshcherbo, M. I.; Prokopenko, L. G. (Kurskii State Medical Inst., USSR). Radiobiologiya, 6: 921-2(1966). (In Russian).

In one series of experiments, 18 rabbits were subjected to local irradiation in the region of the liver at doses of 600, 1000, and 1200 R; 24 hours after irradiation, the animals were injected subcutaneously with E. coli. There was no antibody formation in the liver under these conditions and its inclusion in immunogenesis was consequently independent of decomposition of the repressors of specific protein synthesis. Substantially more bacterial, soluble, and sorbed antigens were accumulated in the livers of the irradiated rabbits than in healthy animals. In special experiments conducted to determine the possibility of stimulation of the liver cells by decomposition products of radiosensitive tissues, donor rabbits were subjected to whole-body γ irradiation at a dose of 1000 R. Spleen and lymph nodes obtained from these rabbits 22 hours after irradiation were used to prepare a suspension, which was transplanted intravenously into nonirradiated recipients. The latter were immunized an hour later by subcutaneous injection of S. paratyphi B. and E. coli vaccines. Transplantation of cells and immunization were repeated after 10 days; tissues of various organs of the recipient rabbits, obtained 48 hours after the second injection of the antigen, were cultured and antibodies determined in the culture fluid. The rate of antibody synthesis in the livers of the irradiated animals and in the livers of healthy rabbits that received injections of a cell suspension of the lymphoid organs was approximately the same; the antigen content in the recipient rabbits was substantially lower. It is concluded that activation of the cellular elements of the liver by decomposition products of the lymphoid tissue (rather than the accumulation of antigen) is the main cause of the inclusion of this organ in immunogenesis under the action of ionizing radiation on the organism. (JPRS)

36726 INFLUENCE OF ANOXIA DURING AND AFTER IRRADIATION UPON RADIATION DAMAGE TO THE LYMPHOCYTES. Smirnova, I. B. (Inst. of Animal Morphology, Moscow). Radiobiologiya, 6: 826-32(1966). (In Russian).

The influence of anoxia during and after irradiation upon the radiation damage to the lymphocytes was studied on lymphocytes from the axillary lymph nodes of white mice and black mice of the C57 line, subjected to x irradiation of 50 to 10,000 R at dose rates from 9.5 to 396 R/min. Irradiation of the lymphocytes in the anoxic state of (irradiation 10 to 15 min after sacrifice) reduced the radiation damage. The creation of anoxia (for 15 to 20 min) immediately after x irradiation reduced the radiation damage to the same degree as anoxia during irradiation. The antiradiation effect was retained if the time between the end of irradiation and the onset of anoxia was increased to 60 min. Lymphocytes that retained the normal nuclear structure as a result of the effect of anoxia exhibited the ability to form pyknosis in response to repeated irradiation equally with intact cells, indicating a retention of viability during the investigated period after the x irradiation. Similarities to the action of cysteamine are discussed. (JPRS)

36727 ON THE INITIAL DAMAGES TO THE NUCLEAR STRUCTURES BY IONIZING RADIATION. Strazhevskaya, N. B.; Struchkov, V. A.; Kalendo, G. S. (Inst. of Biological Physics, Moscow). Radiobiologiya, 6: 783-9(1966). (In Russian).

A complex investigation was conducted to determine the role of enzymes and physiological agents in the rapid change in the supermolecular structures of DNA after irradiation, to demonstrate the specificity of the action of radiation, and to establish the sequence of reactions in the irradiated cell. The role of physiological factors in changing the supermolecular structures of DNA of the rat thymus was evaluated under conditions of shielding and local irradiation of the region of the thymus, as well as after the injection of various doses of adrenalin. A histological investigation (cell composition, mitotic activity, and pyknosis) was conducted simultaneously, and the dynamics of the changes in the supermolecular structures of DNA were compared with the morphological changes to establish the sequence of events in the cell nucleus after irradiation. It was found that after γ-irradiation of rats to 1 kR, the early changes in the elastoviscous properties of the supermolecular structures of

DNA are correlated with the stoppage of mitosis, but precede the appearance of pyknosis and are not associated with the change in the cellular composition of the thymud tissue. Immediately after total and local irradiation at a dose of 1 kR, the change in the elastoviscous properties of the supermolecular structures of DNA of the rat thymus was of the same order of magnitude (35 to 40%). In the case of total irradiation with lead shielding of the thymus, no significant effect upon the supermolecular structures of DNA could be detected immediately after irradiation. The effect was substantial after 24 hours. At doses of 5 and 15 kR, the effect of irradiation on the elastoviscous properties of the supermolecular structures of DNA remained at the same level for one to two hours, indicating that enzymes do not participate in this effect. The early irreversible changes in the physicochemical properties of the chromatin DNP in the irradiated cell were confirmed by histochemical investigations. A change in the elastoviscous properties of the supermolecular structure of DNA was also observed under the action of exogenous adrenalin. But adrenalin was found to follow a different mechanism from radiation: the changes are reversible, rather than irreversible, there is a definite threshold for the effect, and histochemical investigations did not reveal any changes in the physicochemical properties of the DNP of the nuclear chromatin. (JPRS)

36728 DEVASTATION OF THE BONE MARROW AS A QUANTITATIVE CRITERION OF RADIATION INJURY. 1. SELECTION OF THE PERIOD FOR PLOTTING THE DOSE-EFFECT CURVES. Kabakov, E. N.; Perestoronina, N. N.; Gorbunova, V. G. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya, 6: 779-82(1966). (In Russian).

An effort was made to discover a sufficiently simple interrelationship between the absolute number of myelokaryocytes and the total radiation dose, that could be used as a basis for judging the radioresistance (natural or induced) of hematogenic tissue with a minimum expenditure of time. Rats and mice of various strains were subjected to whole-body γ-irradiation at doses from 150 to 5000 roentgens (100 roentgens/sec). The animals were killed at various intervals up to three days after irradiation, and the number of nucleated cells of the bone marrow was determined, along with a simultaneous assessment of the change in the total number of leukocytes in the peripheral blood. An exponential time versus effect curve was obtained in a study of bone marrow destruction during the early periods after total irradiation of rats of the inbred August line. The decrease in the number of myelokaryocytes during this interval was practically independent of the radiation dose; this is therefore an unsuitable index for radiosensitivity of the bone marrow during the early period. In contrast to previous studies, no latent period in the myelokaryocyte decrease was observed. Another series of experiments on rats of three strains (inbred August, heterozygous Wistar, and a wild albino strain) was aimed at selecting a period during which the ratio of the time versus effect curves would possess the simplest dependence upon the radiation dose, on the basis of the observed dynamics of bone marrow destruction. It was found that the level of bone marrow destruction does not exhibit the desired dose dependence until the fourth day. Postradiation leukopenia was found to obey essentially the same principles as bone marrow destruction, both in the three strains of rats and in a strain of mice (C57BL/6). It was emphasized that the criterion selected for evaluating radiation damage to the bone marrow is arbitrary; the level of maximum decrease in myelokaryocytes, which more accurately characterizes the state of the hematogenic tissue, does not always occur exactly on the fourth day. The integral index chosen, however, does possess advantages: a quantitative characteristic of the radiosensitivity of the system can be obtained without determining the true ratio of destructive and repair components responsible for the recorded bone marrow destruction, and may be used in the future for biological dosimetry. (JPRS)

36729 PECULIARITIES OF THE DAMAGING EFFECT OF AN UNEVEN X-IRRADIATION. Avetisov, G. M.; Darenskaya, N. G. Radiobiol.-Radiother., 8: No. 1, 109-20(1967). (In German).

In an experiment with male rats the peculiarities of the radiation-syndrome in six different uneven fields of whole-body irradiation were determined. It was shown that for the evaluation of irradiation in units of the exposure dose there are differences in the values of $LD_{50/30}$ for the investigated methods of irradiation. These differences are nearly completely absent when the evaluation was done in units of the average absorbed tissue-dose. The necessity of further investigations of the quantitative dependence of the biological effect on the spatial distribution of the absorbed dose will be considered. (auth)

36730 EXAMINATIONS OF THE INFLUENCE OF A BIAXIAL TELECOBALT THERAPY IN GYNECOLOGICAL CARCINOMAS ON THE HUMAN WHITE BLOOD-PICTURE. Schmidt, R.; Horst-Meyer, H. zur (Univ., Berlin). Radiobiol.-Radiother., 8: No. 1, 99-102(1967). (In German).

Under a therapeutical biaxial telecobalt therapy of gynecological carcinomas, a continuous decrease of lymphocytes in the peripheral blood-picture to 35 to 25 per cent of the initial value was observed. The response of granulocytes depends on inflammation. In a course of irradiation without complications, granulocyte counts decrease continuously. In arising complications granulocytes are poured out from the reserves into the blood. (auth)

36731 EXAMINATION OF THE ENTERAL ^{51}Cr-ALBUMIN EXCRETION IN ABDOMINAL IRRADIATIONS. Loebe, J.; Schneider, H.-G. (Karl-Marx-Univ., Leipzig). Radiobiol.-Radiother., 8: No. 1, 47-50(1967). (In German).

Excretion of ^{51}Cr-labeled serum albumin was examined in 10 patients before and after telecobalt therapy for gynecological tumors. The increase found in all cases suggests a radiation-induced increase of the enteral protein loss. The increased excretion of protein during abdominal irradiation is supposed to be caused by disturbances of the albumin resorption and an increased capillary permeability of the small intestinal mucous membrane. The absence of changes in the serum protein picture are explained by a momentary increase of albumin synthesis. (auth)

36732 EFFECTS OF IONIZING RADIATION ON THE BONE SYSTEM IN THE FETUS AND NEW BORN ANIMALS. Adamyan, T. V. (Radiobiology Section, Ministry of Public Health, Erevan). Biol. Zh. Arm., 20: No. 4, 42-5(Apr. 1967). (In Russian).

Chronic irradiation of pregnant mice with x and ^{60}Co γ radiation caused sharp and monotypic changes in the bone system of fetuses. Chronic irradiation at doses of 1 to 15 R did not produce any changes in the fetal bone system; doses of 30 R produced a decided change. Results confirmed the dangers inherent in the use of ionizing radiation for medical diagnosis during pregnancy. (B.H.S.)

36733 IMMUNIZATION OF ONE-DAY-OLD CHICKEN WITH IRRADIATED SYNGAMUS TRACHEA LARVAE. Varga, Istvan. Magy. Allatorv. Lapja, 21: 197-200(May 1966). (In Hungarian).

Tests were conducted to establish whether immunization with irradiated (^{60}Co) larvae of Syngamus trachea would impart resistance to syngamosis in one-day-old chickens. The tests involved over 1000 animals from infected and non-infected farms. The degree of protection was greater if the chickens were younger (almost total protection if they were one day old but only about 50% if they were two weeks old). Both laboratory and field tests indicated that resistance can be imparted by this technique. The effective dose was 150 irradiated larvae per animal. (JPRS)

36734 LENTICULAR CHANGES IN MICROWAVE WORKERS. A STATISTICAL STUDY. Cleary, S. F.; Pasternack, B. S. Arch. Environ. Health, 12: 23-9(Jan. 1966).

An analysis of the relative incidence of lens changes in a sample of microwave workers and a control sample revealed a statistically significant increase in rate of accumulation of specific types of defects in the lenses of microwave workers. It was also noted that specific areas of microwave work specialization differ in regard to incidence of lens defects and correlations with microwave exposure parameters. Since the number of defects increased significantly with age in the control group as well as in the group of microwave workers, this process may be interpreted as indicating lens ageing. Occupational exposure to microwave radiation may be implicated as a stress that increases the rate of lens ageing. (auth) (Occup. Safety and Health Abstr.)

36735 STUDIES ON RADIATION RENAL DAMAGES. I. CHANGE OF RENOGRAM FOLLOWING X-RAY IRRADIATION IN THE KIDNEY OF ADULT DOG. Mizoguchi, Masaru (Hiroshima Univ.). Hinyokika Kiyo, 12: 932-45(Sept. 1966). (In Japanese).

Radiation damage to the kidneys was induced in 15 dogs by various doses of x radiation to the site of the left kidney. The experimental animals were divided into five groups and administered the following radiation doses: 1000 R, 1500 R, 2000 R, and 3000 R. Renograms were obtained using ^{131}I-hippuran. The irradiated kidney showed impaired function in all groups. Renograms of the kidney of the non-irradiated side also indicated impaired functioning. (TSS) (NSA of Japan)

36736 EFFECTS OF X IRRADIATION ON TOXICITY OF MALATHION, HEPTACHLOR, AND TEMIK TO THE HOUSE FLY. Guenther, Albert W. (Dept. of Agriculture, Columbus, Ohio); Ware, George W. J. Econ. Entomol., 60: 369-73(Apr. 1967).

Single doses of insecticide were applied to flies Musca domestica, that developed from pupae which had been x irradiated with doses of 7500 and 10,000 R, and to flies receiving 25,000, 50,000, and 75,000 R immediately before topical application. Generally, irradiation of pupae increased toxicity of heptachlor to males and females, reduced significantly the toxicity of malathion to females with no effect on males, and reduced significantly the

toxicity of Temik (2-methyl-2-(methylthio)propionaldehyde O-(methylcarbarbamoyl)oxime) to males, with no effect on females. Irradiation of adults had no evident effect with heptachlor for either sex, had no effect with malathion, and increased significantly the toxicity of Temik to both sexes at 75,000 R. It is suggested that the phenomenal response observed with malathion may be attributed to altered ratios or increased levels of esterases involved in detoxication of this agent. (BBB)

36737 LASER NONCOLYSIS. New Engl. J. Med., 276: 983 (Apr. 27, 1967).

Research on biological effects of laser radiation is discussed in terms of failures in use of the laser in antitumor therapy. Focused laser beams can deliver astronomical fluxes of energy to microscopic targets or to the retina, and harmful, ill-defined effects of the radiation can be observed in tissue cultures. Despite 5 yr of antitumor studies little has been accomplished by this tremendous effort. Experiments are still descriptive, and controls are often absent. The problem is that they have been performed outside the mainstream of the scientific method. Few workers stopped after the preliminary experiments to seek a quantitative expression of laser-tissue interaction, so that even today little progress has been made in delivering reproducible amounts of energy to a target and in measuring the amount absorbed. Matched controls for electric-field effects and wavelength and temperature of the laser radiation are seldom specified. Effort is spent in repeating fundamental work on absorption of radiant energy in ignorance of established facts. (BBB)

36738 INFLUENCE OF X IRRADIATION UNDER HYPOTHERMIA UPON RETICULOENDOTHELIAL SYSTEM OF RABBIT WITH TUMOR. Fushimi, Hajime (Shinshu Univ., Japan). Shinshu Igaku Zasshi, 14: 788-812(Dec. 1965). (In Japanese).

The effect of x radiation on the function of the reticuloendothelial system (RES) under low temperature anesthesia was studied and compared with that under normal temperature. The Congo red method and the India ink phagocytizing function test for subcutaneous histiocytes were used. Normal rabbits and rabbits transplanted with Brown-Pearce tumor served as test animals. The animals transplanted with the tumors were divided in two groups. In one group, irradiation was made on the fourth day after transplantation when the tumor remained more or less within the transplant site. The second group was irradiated on the seventh day when the tumor had spread. Doses of 3000 and 5000 R were used to irradiate the rabbits at normal and low (24 to 25°C) body temperatures (rectal). Results were compared with those for normal rabbits that received the same doses in an identical manner. At both doses in the normal rabbits, smaller impairments of the RES function were caused at low temperature than at normal temperature. The animals with the tumors that were irradiated on the fourth day after transplantation showed results similar to those for the normal rabbits, the RES function tended to be impaired far less when the rabbits were irradiated at low temperature. In the group that was irradiated on the seventh day, the disturbance of the RES function was recognized invariably at the dose of 3000 R; the disturbance tended to be less at low temperature and at the 5000 R dose. Patients with cancer of the breast were subjected to 1000 R-doses of x radiation at low (29.4°C) and normal body temperatures; it was found that irradiation did not impair RES function as much at low temperature as it did at normal temperature. (TSS) (NSA of Japan)

36739 SKIN REACTIONS FROM GOLD JEWELRY CONTAMINATED WITH RADON DEPOSIT. Simon, Norman; Harley, John (Mount Sinai Hospital, New York). J. Amer. Med. Ass., 200: 254-5(Apr. 17, 1967).

Gold jewelry may be contaminated sufficiently with radiation to represent a hazard to the wearer. Effects of wearing gold rings containing decay products of Rn are described. It is recommended that gold to be used for jewelry or dental fillings be monitored for radioactivity. (TSS) (BBB)

36740 SOME NUCLEAR FACTORS IN RADIOSENSITIVITY. Conger, Alan D. (Temple Univ., Philadelphia). Nat. Cancer Inst. Monogr., No. 24, 129-39(Feb. 1967).

Two aspects of radiobiology which have bearing on radiotherapy are discussed: the relation of nuclear volume, or chromosome volume, to radiosensitivity, and the fact that with chronic or split-dose irradiation, radiosensitivity is often related to length of the cell cycle. In general, all higher plant species irradiated in the LD_{50} to LD_{100} range die of the same cause: radiation killing of the proliferating growing tips on stem and root, so intercomparisons are valid. The situation is similar to that for mammalian species dying of damage to the hematopoietic tissue in the LD_{50} range. Of many criteria initially examined to explain the observed differences in radiosensitivity, two correlate very well with radiosensitivity: the nuclear volume and average volume per chromosome, the latter correlating better. The interphase chromosome volume (ICV) correlates even better with radiosensitivity; it is the nuclear volume in interphase divided by the number of chromosomes in the cell and is the average volume of one chromosome for the species. Some results illustrating the correlation of LD_{100} to average ICV are shown. It was demonstrated that an equal energy deposition per chromosome will cause an equal amount of damage, 100% killing, in all species, even though their chromosomal volumes differ by a factor of almost 300. In terms of this biological dose (energy absorbed per chromosome), the biological LD_{50} or LD_{100} is the same for all these species, whereas the physical LD_{50} or LD_{100} (energy/g) is grossly different (a factor of 125-fold). As to the 2nd concept discussed, under chronic or even split-dose irradiation, the amount of damage caused per unit dose is proportional to the length of the cell cycle. Therefore, in radiotherapy the fractionation schedule should be adjusted to the rate of tumor cell multiplication. (BBB)

36741 POSSIBLE ROLE OF NEUROGLIA IN THE APPEARANCE OF BRAIN BIOELECTRIC REACTIONS TO A CONSTANT MAGNETIC FIELD. Aleksandrovskaya, M. M.; Kholodov, Yu. A. (Inst. of Higher Nervous Activity and Neurophysiology, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 170: 482-5(Sept. 11, 1966). (In Russian).

The reactions of neurons and glial cells in the brains of rabbits and cats exposed to constant magnetic fields of 200 to 300 Oe acting on the head alone were examined. EEG's and functional tests (reactivity curves) were conducted on the animals, and they were killed after 1, 10, and 60 to 70 hr of exposure for morphological studies of CNS tissue effects. The findings are described. (TSO)

36742 SUNLIGHT AND SKIN. II. PHOTOSENSITIVITY DISORDERS. Honeycutt, W. Mage; Dillaha, Calvin J.; Jansen, G. Thomas (Univ. of Arkansas, Little Rock). J. Arkansas Med. Soc., 61: 182-90(Nov. 1964).

Effects of uv light, interacting with various exogenous chemical compounds in skin, are reviewed. A list is given of the drugs, cosmetic ingredients, and plants that may cause photosensitivity reactions. Among the listed antibiotics, demethylchlortetracycline is the most frequent photosensitizer. The clinical picture of the reaction is that of an exaggerated sunburn, sharply limited to exposed areas. It is usually dose-dependent. One aspect of demethylchlortetracycline photosensitivity, not seen in other drug photosensitivity reactions, is onycholysis, or separation of the nail plate from its bed. Tetracycline and chlortetracycline may also cause photosensitivity. Many photosensitizing agents are from coal tar and its derivatives. Many plants are known to induce photosensitivity on contact. The two principal groups of plants causing this reaction are the Umbelliferae and Rutaceae, the members of which owe their photosensitizing properties to their furocoumarin content. The most common manifestation of the photosensitive state is the polymorphous light eruption (PML). It is so-called because of the variable and mixed clinical picture it may present. The types of PML include persistent erythema, papulo-vesicular, eczematous, plaque-like, and urticarial (solar urticaria) reactions, or a mixture of these. The mechanism of production of PML is postulated to be an antigen-antibody reaction, the antigen being a normal constituent of skin made antigenic through some molecular change brought about by the absorption of energy from uv irradiation. (BBB)

36743 REMARKS ON THE BEHAVIOR OF GAMMA-IRRADIATED HYPHANTRIA CUNEA DRURY CHRYSALISES. Boguleanu, Gh. Stud. Cercet. Biol., Ser. Zool., 17: 387-91(1965). (In Romanian).

In the first series of experiments, chrysalises aged 1 to 8 days were exposed to a single radiation dose of 30,000 R. In the second series, chrysalises aged 3 to 5 days were exposed to doses ranging between 10,000 R and 60,000 R. Irradiated chrysalises were obtained from larvae belonging to the first generation, raised on maple trees under natural conditions. The studies concerned adult occurrence, copulation, laying of eggs and eclosion as related to irradiated males and normal females. The experiments revealed a wide variability concerning the radiosensitivity of Hyphantria cunea Drury chrysalises with age. Thus, chrysalises aged 5 to 8 days exposed to a dose of 30,000 R showed an almost normal behavior, while those aged 1 to 4 days were unfavorably affected by the experiment. (Romanian Sci. Abstr.)

36744 RADIOTHYROIDECTOMY IN THE SALMONID FISHES SALMO GAIRDNERII RICHARDSON AND ONCORHYNCHUS TSHAWYTSCHA WALBAUM. Norris, David Ott. Seattle, Wash., Univ. of Washington, 1966. 133p.

Thesis.

The orienting purpose of the investigation was to evaluate the importance of thyroid hormones in the physiology and migratory behavior of steelhead trout and chinook salmon. A technique was

developed for destroying the thyroid gland by administration of ^{131}T; the general pathological effects of the treatment were evaluated. Controls for the amount of external whole-body irradiation were prepared. The absence of recognizable thyroid tissue and the lack of accumulation of tracer doses of ^{131}I in serial sections were used as criteria for completeness of radiothyroidectomy. Following ^{131}I immersion of steelhead and chinook, the degeneration of thyroid cells was characterized by cytoplasmic vacuolization, disappearance of colloid, and disintegration of follicular structure. Evidence of hypophyseal stimulation appeared in the increased frequency of mitotic figures in thyroid cells. Lymphocytic infiltration began soon after ^{131}I exposure, and there was considerable proliferation of connective tissue elements. Extensive connective tissue growths, hyaline degeneration of the walls of major pharyngeal blood vessels, and fusion of gill lamellae were observed only in steelhead treated as fry with ^{131}I. Occasionally small abnormal growths of connective tissue were found in steelhead and chinook treated as alevins with ^{131}I. All thyroid tissue was completely destroyed two to three weeks after radioiodide exposure of chinook alevins. A greater degree of lymphocytic infiltration and the longer time course of thyroid destruction in steelhead (7 to 22 weeks) suggested that an autoimmune response might be involved in thyroid destruction following initial injury by accumulated radioiodine. However, circulating antibodies against thyroidal antigens could not be demonstrated in steelhead trout one to fourteen months after ^{131}I treatment. Radiothyroidectomy induced hypertrophy and cytoplasmic vacuolization of certain basophilic cells in the rostral pars distalis of the adenohypophysis. Later hyperplasia of these cells produced a moderate enlargement of this region of the adenohypophysis. These cells were presumed to be thyrotrophs. No changes were observed in acidophilic cells. A striking consequence of ^{131}I immersion was a marked increase in integumentary pigmentation. The relation among thyroid hormones, radiation, and pigmentation are discussed. One year after radioiodide treatment the ovaries of radiothyroidectomized steelhead consisted of one class of oocytes indistinguishable from the largest of several classes of oocytes found in untreated and irradiated animals. No differences were seen in testicular and hepatic histology at this time. The growth rates of normal, irradiated, and radiothyroidectomized steelhead and chinook were examined. It was assumed that the effects of radiothyroidectomy on growth would adequately reflect the sum total of physiological alterations in radiothyroidectomized fish. The growth rates of radiothyroidectomized fish were significantly reduced as compared to untreated and irradiated animals. An apparently normal rate of growth could be restored by treatment of radiothyroidectomized steelhead with thyroxine. The effects of thyroid hormones on differential growth are discussed, and suggestions are made concerning the regulation of teleostean growth by thyroid hormones. The most controversial behavioral role for thyroid hormones has been their involvement in the seaward migration of juvenile salmonids. An experimental analysis of migratory behavior in two year classes of radiothyroidectomized and control steelhead showed that normal smolting can occur in the absence of thyroid tissue, and some radiothyroidectomized smolts will migrate seaward together with normal smolts. The results indicate that the thyroid gland is not a causative agent in the initiation of migratory behavior, and the possible involvement of thyroid hormones in the generally increased activities of migrating animals is suggested. (Dissertation Abstr.)

36745 RADIOTOKSINY, IKH PRIRODA I ROL V BIOLOGICHESKOM DEISTVII RADIATSII VYSOKOI ENERGII. (Radiotoxines, Their Properties and Role in the Biological Effects of High Energy Radiation). Kuzin, A. M. (ed.). Moscow, Atomizdat, 1966. 293p.

Theoretical and experimental data are presented in the forty-one articles on the development of radiotoxins in irradiated organisms, quantitative regularities of their formation, chemical nature and wide spectrum of radiomimetic properties of these substances. Mechanism of formation and identification of basic substances of quinone origin that are formed in irradiated organisms, formation of quinone in liver of irradiated animals, inhibition of DNA synthesis during the local irradiation of the cytoplasm and nuclei, reaction of quinones with the cell nucleus, effects of radiotoxins on DNA synthesis in plants, and effects of plant radiotoxins on acidic cancerous cells in animals are discussed. Restoration of radiation injuries in γ-irradiated seeds, effects of protective substances on the yield of basic products during radiolysis of amino acids, effects of lipid radiotoxins on organs and tissues, toxicity of lipids in irradiated animals, and morphological and histochemical alterations in organs of animals exposed to the effects of lipid radiotoxins were examined. Injuries to the surface layer of erythrocytes under the effects of irradiated and nonirradiated unsaturated fatty acids, alteration of free histamine in tissues of rats, participation of humoral toxic agents in development of various radiation injury syndromes, remote radiation effects on hematopoietic organs, and the role of regenerating tissue metabolism in radio resistance are discussed as well as the effect of toxins on radiation injury of infected cotton plants. (R.V.J.)

Radiation Effects on Plants

Refer also to abstracts 36547, 36548, 36550, 36740, and 36745.

36746 (NYO-2043-152) THE APPLICATION OF NUCLEAR ENERGY TO AGRICULTURE. Annual Report. Moh, Carl C. (Inter-American Inst. of Agricultural Sciences, Turrialba (Costa Rica)). July 1, 1967. Contract AT(30-1)-2043. 165p. Dep. CFSTI.

TREES—radiation effects on growth of nine species of tropical fruit
PLANTS—radiation effects on growth of cactus, γ
BEANS—radioinduced mutations in Phaseolus, effects of exposure during various phases of life cycle on γ
METHANESULFONIC ACID—ethyl ester, effects on beans, mutagenic mutations induced by EMS
GIBBERELLIC ACID—effects on growth of dwarf bean mutants
GENES—transfer of, effects of, on genotypic ratio of beans
GAMMA RADIATION—effects on cuttings of Manihot esculenta, genetic
FUNGI—radioinduced mutations in Neurospora crassa, γ
FRUITS—infection of tropical, by anthracnose fungi
FRUIT FLIES—radiosterilization of Ceratitis capitata, effects of, on population control, γ; diet for rearing Mediterranean
INSECTS—radiosterilization of Leucoptera coffeella, effects of, on population control γ
SOILS—analysis for carbon, nitrogen, and phosphate content, tropical; chemistry of tropical (C.H.)

36747 (ORO-3299-6) EFFECTS OF IONIZING RADIATION ON A PINE FOREST. McCormick, J. Frank (North Carolina Univ., Chapel Hill, Dept. of Botany). May 1, 1967. Contract AT(40-1)-3299. 22p. (CONF-670503-21). Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

In August, 1964 a slash-longleaf pine forest was exposed to a portable 9200 Ci ^{137}Cs source for 200 hours. The ecological effects of radiation were interpreted on the basis of the following: species mortality; inhibition of apical and lateral growth; influence of species age and size upon radiation sensitivity; microenvironmental changes; changes in the herbaceous understory; and the recovery pattern of lethally irradiated areas. The forest is the most radiation sensitive ecosystem yet investigated. Dominant species were killed by exposures of 3kR and growth inhibition resulted from exposures as low as 100R. Ecosystem recovery was rapid. Lethally irradiated pines were replaced by Heterotheca subauxillaris and other species characteristic of old-field succession. The pine forest is 25 to 50 times as sensitive as herbaceous old field and outcrop ecosystems; 10 to 15 times as sensitive as a tropical rain forest; and 5 to 10 times as sensitive as a deciduous-evergreen forest. Estimates of coniferous forest radiation resistance exceed by 5 to 6 orders of magnitude the levels of radioactivity found in the natural forest, but forest sensitivity falls well within the range of exposure doses predicted for a hypothetical nuclear war. (auth)

36748 INDUCED CHROMOSOMAL ABERRATIONS AND OTHER ABNORMALITIES IN THE EMBRYO SAC FOLLOWING POLLEN IRRADIATION IN MELANDRIUM RUBRUM. Vassileva-Dryanovska, O. A. (Agricultural Coll., Uppsala). Hereditas, 55: 149-59(1966).

In Melandrium rubrum (n = 12), which has trinucleate type of pollen grains, the pollen was irradiated with exposures of 1 to 500 kR of x and gamma rays. After pollination with irradiated pollen observations were made on the growth of pollen tubes, the process of fertilization, the development of embryo and endosperm, and seed formation. All became more abnormal with increasing radiation doses. Three types of fusion of the irradiated sperm nuclei with the female nuclei observed and three different patterns observed in the endosperm are described. The chromosomal aberrations showed the chromosomes to be in the duplicated stage in the sperms of the pollen grains. Seeds were formed after exposure to 1 to 500 kR. The reduction in number of seeds increased with increased exposure. The pollen grains of Melandrium are more radioresistant than those of Tradescantia, which might be due to the difference in type of the pollen (trinucleate and binucleate, respectively), the stage of the male chromatin, and/or the number and size of the chromosomes. (auth)

36749 EFFECTS OF MUTAGEN TREATMENT ON SOME APOMICTIC POTENTILLA SPECIES. Asker, Sven (Inst. of Genetics, Lund, Sweden). Hereditas, 55: 249-65(1966).

The mutagenic effects of x rays and ethyl methane sulfonate were studied on different apomictic biotypes of four species of Potentilla. Seeds of this material have a high resistance against mutagenic treatment. The germination is not even influenced by very high radiation doses. The number of surviving plants increases with higher chromosome numbers. In P. argentea, the survival is greater than in biotypes with the same chromosome number in the other species used, P. collina, Crantzii, and Tabernaemontani. The aberrations observed in X1 and later generations are described, including some very peculiar types. The possibility of inducing sexuality in apomictic species by mutagen treatment is discussed. In Potentilla there are only indications that the very small frequency of fertilized egg-cells is somewhat increased in mutagen-treated material. Complete breakdown of apomixis and reversal to sexuality are not found. (auth)

36750 EFFECT OF γ-IRRADIATION OF SEEDS ON THE DEVELOPMENT OF MALE AND FEMALE FLOWERS OF CUCUMBER PLANTS. Sidorskii, A. G. (State Pedagogic Inst., Arzamas, USSR). Radiobiologiya, 7: 138-40(1967). (In Russian).

The effect of irradiation of cucumber seeds with 1 to 40 kR of γ rays on the relative development of male and female flowers on plants grown from these seeds was studied. In the first months of vegetation of the plants there was a shift of the male/female flower ratio towards the male side, while the ratio changed to the female side in late stages of development of the plants. The ratio of male to female flower vestiges was always higher than that of male to female developed flowers—i.e., female flowers were more resistant to radiation. With increasing age of the plants grown from irradiated seeds, the fertility of pollen decreased. The rate of decrease increased with increasing doses of radiation; after the seeds had been irradiated with 40 kR, all the pollen was sterile in the first month of flowering of the plants. (JPRS)

36751 THE INDUCTION OF HAPLOID EMBRYOS AND TETRAPLOID ENDOSPERM NUCLEI WITH IRRADIATED POLLEN IN LILIUM. Vassileva-Dryanovska, O. A. (Agricultural Coll., Uppsala). Hereditas, 55: 160-5(1966).

Flowers from Lilium speciosum were pollinated with mature pollen exposed to 1 to 500 kR of x or γ radiations. Pistils were collected at different stages (1 to 30 days after pollination) for cytological studies. After irradiation with 50 to 500 kR the growth of the pollen tubes was inhibited and abnormal mitoses such as fragments, rings, bridges, and stickiness were observed. Nuclear fusion after irradiation with 1 to 20 kR resulted in embryos with acentric fragments, micronuclei, and lobed nuclei. These embryos developed more slowly than the controls. Embryos which developed following irradiation with more than 50 kR appeared to be haploid. In the endosperm which developed after doses of 1 to 20 kR, normal and abnormal mitoses occurred. The latter were more frequent at the higher doses and exhibited giant or lobed nuclei, bridges among sister nuclei, nuclear mosaicism, micronuclei, acentric fragments, acentric and dicentric rings, dicentric bridges and stickiness. Above 50 kR abnormal development resulted with eventual degeneration. It appeared that haploid embryos and tetraploid endosperm resulted from stimulation by pycnotic male chromatin or pseudogamically under the influence of the developing endosperm. Seeds were not formed after doses above 5 kR. (TSS)

36752 ACTION OF γ-RADIATION AND OF RADIATION TOXINS ON THE MERISTEM OF RYE ROOTS. Filippova, N. F. (Inst. of Biological Physics, Moscow). Radiobiologiya, 7: 141-4 (1967). (In Russian).

A comparative study was carried out of the action of γ-radiation and radiation toxins on the meristem of rye roots. The toxins were extracted with aqueous alcohol from potato tubers irradiated with 10 kR of γ rays and applied in various dilutions. There was a complete correspondence between the action of γ radiation and of the radiation toxins. The number of cells with chromosome aberrations increased in the same manner with increasing concentrations of toxins as with increasing doses of γ radiation. Accumulation of cells with pyknosis of nuclei in the prophase proceeded according to the same law under the action of the toxins and of γ radiation. Pyknotic alteration of the nucleus was apparently characteristic for low radiation doses and small toxin concentrations. The cells of the lateral meristem were more sensitive than those of the axial cylinder to the action of both γ radiation and the radiation toxins. (JPRS)

36753 THE EFFECT OF REPEATED GAMMA RADIATION ON YIELD [OF COTTON]. Kabulov, D. T.; Muminov, M. M.; Ismailov, F. I. (Samarkand State Univ., USSR). Khlopkovodstvo, 15: No. 7, 51-2(1965). (In Russian).

Cotton seeds were irradiated annually for three successive generations using γ radiation doses of 600 to 800 R from a ^{60}Co source. Rates of germination and bud formation were increased, but other stages of growth were normal. The number of bolls per plant was increased by 2 to 2.9 in irradiated plants, and earlier boll opening occurred in irradiated plants. An increase in yield of 8 g of fiber per plant occurred in the first year and an increase of 16 g occurred in the second year. After the third year of irradiation, there was an increase in oil content of seeds. (H.L.W.)

36754 THE PATTERN OF CHROMOSOME ABERRATIONS AFTER THE X-IRRADIATION OF TRILLIUM GRANDIFLORUM POLLEN. Grant, C. J. (Oxford Univ.). Mutat. Res., 4: 307-14(May-June 1967).

The chromosome aberration pattern is described in Trillium grandiflorum pollen irradiated during the post-meiotic interphase. The pattern compares with that found in irradiated root tips of the same species; but in the pollen the heterochromatin has an effect on the type and distribution of aberrations. After increasing x-ray doses both chromatid inter-changes and intra-changes increase approximately as dose. This is interpreted to favor the exchange hypothesis for aberration formation; but it is pointed out that this hypothesis, as it stands, may not satisfactorily account for aberrations induced during chromosome replication. (auth)

36755 EFFECTS OF VARIOUS DOSES OF IONIZING RADIATION ON THE TAKING AND DEVELOPMENT OF GRAPE-VINE GRAFTS. Avramov, Lazar; Mijajlovic, Radisa (Faculty of Agriculture, Zemun, Yugoslavia). Arh. Poljopr. Nauke, 18: No. 61, 16-25(1965). (In Slovak).

The radiation doses of 250, 500, 1,000, and 2,000 R did not show any unfavorable effect on the tolerance of grape vine grafts. However, a dose of 4,000 R had an unfavorable effect, by lowering the rooting of grafts to 30%. Doses of 1,000 R had a favorable effect in increasing the average weight of grafts, the number of roots, length of roots, and length and weight of shoots. Taken as a whole, this led to an increase of the vegetation potential of the grafts during the first normal planting. The other doses of 250, 500, and 2,000 R had a favorable effect on the variety Gamay Tenturier only, while the effect was unfavorable on the variety Muscat Ottonel White. A dose of 4,000 R had an unfavorable effect on the varieties mentioned, both on the root system and the growth of shoots. (H.L.W.)

36756 EFFECTS OF DEUTERIATION ON FLOWER, FRUIT, AND SEED DEVELOPMENT IN ATROPA BELLADONNA. Crane, F. A. (Univ. of Illinois, Chicago); Blake, M. I.; Uphaus, R. A.; Katz, J. J. Lloydia, 30: 111-20(Mar. 1967).

Belladonna plants were grown in nutrient solutions containing 50, 60, and 70% D_2O. For the first time, D isotope effects in the first, second, and third generation deuteriated plants were compared with suitable control plants. Particular attention was given to the effects of D on flower, fruit, and seed development. A progressive inhibitory growth response with increasing D_2O concentration was evident. At the 70% D_2O level, plant growth was abnormal and unpredictable. Plants grown in 50% and 60% D_2O produced an abundance of flowers, but most of these were small and did not become fertilized. Only a few flowers were observed in the 70% D_2O plants. Flower development was drastically affected by deuteriation. The deuteriated flowers were broader and shorter than controls; the number of calyx lobes, corolla lobes, and stamens, while invariably five in control flowers, increased to as many as nine or 10 in the 70% D_2O flowers. Plants grown in heavy water, or with a history of D_2O exposure, formed abnormally shaped berries. Abnormality in shape resulted from the tenacity with which the corolla remained attached to the maturing berry. As the berry enlarged, a constriction formed at the point of attachment. Other effects of D_2O included production of decreased number and size of seeds. Comparison of plants grown through three generations of exposure to heavy water indicated that the most drastic growth inhibition took place during first generation growth in deuteriated media. After three generations, a degree of adjustment to the D in the environment appeared. (BBB)

36757 EFFECTS OF KINETIN ON CHLOROPHYLL BREAKDOWN IN IRRADIATED BARLEY LEAVES. Giacomelli, M.; Belli Donini, M. L. (CNEN, Casaccia, Italy). G. Bot. Ital., 72: 311-12(1965). (In Italian). (RT/BIO-(66)16).

Kinetin was shown to inhibit the breakdown of chlorophyll in isolated or x-irradiated barley leaves. The possible correlation of these observations with kinetin promoted protein synthesis is suggested. (auth)

36758 EARLY DIAGNOSIS OF THE REACTION OF PLANTS TO SEED IRRADIATION BEFORE SOWING. Zezyulinskii, V. M.; Soldatova, L. G. (All-Union Scientific-Research Inst. of Fertilizers and Soil Science, Moscow). Selek. Semenovod., No. 6, 23-5(1965). (In Russian).

The stage of development in plants at which effects first appear following preliminary irradiation of dry seeds was investigated.

The radiation doses most effective for inducing mutations were determined. A graph showing the growth of various cereal plants from seeds irradiated with high doses of radiation showed that doses of 50,000 R did not affect the germination, sprouting, or appearance of the first leaf. Inhibitory effects began to appear after 4 to 5 days of growth. The degree of radioinduced injury could be determined during the first 15 to 20 days of development. Experiments with cucumbers, tomatoes, radishes, and beans showed that the injury observed during the first stages of development was retained until the harvest. Radiation doses having slightly inhibitory effects were also discussed. (R.V.J.)

36759 RESPONSE OF SOME ORNAMENTAL PLANTS TO FAST NEUTRONS. Love, J. E.; Constantin, M. J. (Univ. of Tennessee, Oak Ridge). Tenn. Farm Home Sci., Progr. Rep., No. 56, 10-12(Oct.-Dec. 1965).

Twenty species of ornamental plants were subjected to acute exposures of unmoderated fission neutrons from ^{235}U. Plants were exposed simultaneously to doses of 0, 300, 600, 900, 1200, or 1500 rads by varying the sample-to-reactor distance. Inhibition of growth was dose- and species-dependent. Radioinduced morphological abnormalities were observed in buds, leaves, and stems. The extent and frequency of the abnormalities increased with dose. Types of bud-mutants observed in different species are tabulated. It was concluded that acute exposure of ornamental plants to fast neutrons appeared to be an effective method for inducing bud-mutants. (B.H.S.)

36760 THE EFFECTS OF GAMMA RAYS ON ALGAE (DESMIDIACEEN). Marcenko, Elena (Institute Rudjer Boskovic, Zagreb). Protoplasma, 62: 156-83(Aug. 5, 1966). (In German).

Effects of γ rays on survival and division of Micrasterias truncata and Netrium digitus are reported. Survival of the latter organism fell off sharply after exposure to 20 kR. The division frequency decreased gradually after exposures of up to 20 kR, and decreased more rapidly as exposures were increased to 30 kR. Growth also was progressively depressed by exposure to similar amounts of γ irradiation. In Micrastenas truncata the effects of γ irradiation at these dose ranges varied in detail, but were similar to those seen with Netrium digitus. It was possible to increase survival of Netrium after exposure to 24 kR by alternation with storage in a dark chamber. Radiosensitivities of Micrasterias during various phases of the division cycles differed. Doses of irradiation that might cause nuclear damage did not inhibit differentiation itself, but blocked further development. Only doses greater than 100 kR showed a significant effect on morphogenesis. The radiation effects varied with the stage of differentiation. The radiation effects were enhanced by lowering the environmental temperatures before or after irradiation. The cells showed increased radiosensitivity during the metabolic phase of development during differentiation. In cells that had not undergone mitosis, mature cells were more radioresistant than young cells. (BBB)

Radiation Effects on Microorganisms

Refer also to abstract 36778.

36761 (N-67-19994) PHYSICS OF CELLULAR SYNTHESIS; GROWTH, AND DIVISION. Progress Status Report, July 1-December 31, 1966. Pollard, E. C. (Pennsylvania State Univ., University Park. Dept. of Biophysics). Mar. 1, 1967. 13p. (NASA-CR-82923). CFSTI.

Previous research in hyperchromicity, density gradients, and related topics is summarized, and details are given on current investigations. In order to study centrifugation of E. coli cells, an experiment was devised, using a polysaccharide material of high molecular weight. The experiment is described and the results discussed. It was concluded that either centrifugation does not force a rearrangement of the internal structure of the bacterial cell or the cell has the ability to function in spite of gross distortion. Preliminary experiments on the effect of radiation on banding position of bacterial cells in a CsCl density gradient are briefly reported; results indicated that gamma irradiation does alter the banding position. Investigation of the mechanism of T_4 replication in uv light-induced filamentous E. coli cells, using radioautographic techniques and genetic recombinational analysis, is briefly described. Finally, research in the effects of radiation on cultured mammalian cells is reviewed. (STAR)

36762 (N-67-18938) RESISTANCE OF CERTAIN STRAINS OF MICROORGANISMS TO ULTRAVIOLET RAYS. Zhukova, A. I.; Kozlova, V. Kh. Translated from Mikrobiologiya, 35: 302-6(1966). 10p. (NASA-TT-F-10720). CFSTI.

The critical uv dose for 28 strains of microorganisms was evaluated. The aim was to select species suitable for experiments under Martian conditions. The most resistant to uv appear to be nonpigmented spore forming bacteria and nonspore-forming yeast possessing pigments of intensive colorations (black, red). Microbial activity in the surface layers of the Martian soil seems to be quite probable judging from the data obtained. (auth) (STAR)

36763 MICROBIAL CONTROL BY LOW-DOSE IRRADIATION. Kivel, Joseph; Chatterton, Margaret S.; Palchak, Robert J. F. (Atlantic Research Corp., Alexandria, Va.). Trans. Amer. Nucl. Soc., 10: 47(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36764 DEGRADATION BY THE HOST CELL OF LAMBDA BACTERIOPHAGE DNA IRRADIATED WITH ULTRAVIOLET RADIATION. Roulland-Dussoix, Daisy (Univ., Geneva). Mutat. Res., 4: 241-52(May-June 1967). (In French).

The uv irradiation of phage λ gives rise to lesions that upon infection of a bacterium are responsible for partial degradation of the phage DNA. The degradation, measured by acid-soluble ^{32}P, reaches 40% of the total phage DNA on a hcr^+ strain and 20% on a hcr^- strain, indicating its relation to host cell reactivation. However, it appears that the degradation found with hcr^- is a consequence of lesions that are not host cell- or photo-reactivable and that this degradation exists also in hcr^+ superimposed upon that due to host cell reactivable lesions. The degradations found on hcr^+ and hcr^- are inhibited by the irradiation of the bacteria or by their treatment with mitomycin C presumably by competition with the degradation of the bacterial DNA. These degradations are also blocked by caffeine that is known to inhibit selectively the host cell reactivation. However, since caffeine generally inhibits nucleases, it is suggested that caffeine specifically inhibits host cell reactivation because this reactivation is the only one requiring one or more nucleases in its mechanism. (auth)

36765 MECHANISM OF INHIBITION OF POST-IRRADIATION RECOVERY OF YEAST BY ETHYL ALCOHOL. Mosin, A. F. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya, 7: 111-16(1967). (In Russian).

The effects of EtOH on post-irradiation recovery, intensity of respiration, and fermentation activity of the diploid yeast Saccharomyces vini (strain Megri 139 B) that had been irradiated with γ rays were studied. Presence of EtOH in the medium (in a concentration of approximately 3.5%) had an inhibiting effect on the restoration of yeast both under aerobic and anaerobic conditions. Addition of EtOH to a suspension of aerated yeast that had been irradiated and was incubated in a non-nutrient medium (sterile water) stimulated respiration to a marked degree. The rate of glycolytic conversion of glucose by the irradiated yeast under anaerobic conditions produced by addition of KCN was greatly reduced by EtOH. The oxidation of glucose under aerobic conditions was also inhibited by EtOH. Among various energy-supplying substrates (glucose, acetate, succinate, ketoglutarate, citrate), the most favorable effect on the recovery of yeast that had been starved for a long period of time by being kept in a non-nutrient medium before irradiation was exerted by glucose. The results indicated that catabolic conversion of glucose in the energy-supplying system of yeast cells is presumably one of the principal processes producing post-irradiation recovery. (JPRS)

36766 ALKALI HALIDES AS AGENTS ENHANCING THE LETHAL EFFECT OF IONIZING RADIATIONS ON MICROORGANISMS. Matsuyama, Akira; Namiki, Mitsuo; Okazawa, Yoshishige (Inst. of Physical and Chemical Research, Tokyo). Radiat. Res., 30: 687-701(Apr. 1967).

Actions of alkali halides such as fluoride, chloride, bromide, and iodide were found to enhance the lethal effect of ionizing radiations on cells of bacteria and yeast suspended in 0.067M phosphate buffer. The data obtained are concerned mainly with the effects of halides present during irradiation. The effects of halide concentration, dose, pH, and freezing on the enhancing actions of halides and also on the aftereffects of irradiation were determined. It was concluded that the possible mechanism for the enhancement by halides may involve the inactivation of a multihit type of short-lived species, which is produced from halide ions by ionizing radiations, but not by ultraviolet light. Different halides, however, appeared to behave differently toward irradiation with respect to forming the long-lived species which could have an influence on the enhancement of radiolethality. (auth)

36767 THE NATURE OF PHOTOACTIVATION IN NEUROSPORA CRASSA. Terry, Claude E. (Oak Ridge National Lab., Tenn.); Kilbey, Brian J.; Howe, H. Branch Jr. Radiat. Res., 30: 739-47(Apr. 1967). (ORNL-P-1960).

The action spectrum for photoreactivation in Neurospora crassa was determined and does not coincide with that of either E. coli or S. griseus, although it overlaps both. No single chromophore is

indicated by the spectrum, although the high efficiency of the 405-nm wavelength is in the region of the porphyrin Soret band absorption. Photoreactivation in Neurospora is temperature-dependent and reduces uv lethal damage by a constant factor. Extracts of Neurospora cause in vitro photoreactivation of uv-irradiated transforming DNA. These observations indicate that there is direct enzymatic photoreactivation in Neurospora crassa. (auth)

36768 ENHANCEMENT OF THE SENSITIVITY OF ANOXIC ESCHERICHIA COLI B/r TO X-RAYS BY TRIACETONEAMINE-N-OXYL. Emmerson, Peter T. (Yale Univ., New Haven). Radiat. Res., 30: 841-9(Apr. 1967).

Triacetoneamine-N-oxyl (2,2,6,6-tetramethyl-4-piperidone-1-oxyl), a highly water-soluble, stable free radical, has been shown to preferentially sensitize anoxic E. coli B/r to the lethal effects of x rays. In the absence of excess radical scavengers in the medium the maximum sensitization is reached at 10^{-3}M, at which concentration the triacetone-amine-N-oxyl (TAN) is about 60 to 70% as effective as oxygen. This concentration is lower, by a factor of 10, than that at which previously studied analogous compounds such as di-t-butyl nitroxide (DTBN) were equally effective. TAN does not sensitize aerobic bacteria, with the result that it reduces the oxygen effect. The normal sensitization due to oxygen in E. coli B/r is decreased from a dose-reduction factor of about 4.0 to about 1.5, by the presence of 10^{-3}M TAN. The compound is well tolerated intraperitoneally in mice, which should permit the performance of in vivo sensitization experiments. (auth)

36769 EFFECT OF ULTRAVIOLET IRRADIATION ON THE ACID-FASTNESS OF DRUG RESISTANT MUTANTS OF TUBERCLE BACILLI, WITH SPECIAL REFERENCE TO THE VIRULENCE OF ISONIAZID RESISTANT STRAINS. Murohashi, Toyoho; Yoshida, Konosuke (National Inst. of Health, Tokyo). Nippon Saikingaku Zasshi, 21: 164-70(Mar. 1966). (In Japanese).

Effect of ultraviolet irradiation on acidfastness was studied on the drug-resistant mutants of tubercle bacilli. Among them, resistant strains to more than 1 μg/ml of isoniazid lost acidfastness, similarly to the avirulent or attenuated ones, by shorter time of uv irradiation than the virulent tubercle bacilli. This phenomenon correlated very well with the pronounced attenuation of virulence in guinea pigs after subcutaneous inoculation. Based on the results the mechanism of isoniazid-resistance was discussed from the standpoint of cell wall structure. (auth) (NSA of Japan)

36770 TWO TYPES OF X-RAY-SENSITIVE MUTANTS OF ESCHERICHIA COLI B: THEIR PHENOTYPIC CHARACTERS COMPARED WITH UV-SENSITIVE MUTANTS. Kato, Takesi; Kondo, Sohei (Osaka Univ.). Mutat. Res., 4: 253-63(May-June 1967).

From radiation-resistant strains (of B/r type) of Escherichia coli B, 18 mutants were selected as uv-sensitive (uvr^-) mutants without any increased sensitivity to uv-induced filament formation. Class II mutants are of $uv\text{-}hcr^-$ type: they are highly sensitive to uv killing in various degrees but only slightly sensitive to x-ray killing; and they lack the ability to reactivate uv-irradiated T_3 phage but have only slightly reduced host cell reactivation ability for x-irradiated T1 phage. Compared with these $uv\text{-}hcr^-$ mutants, five mutants are highly sensitive to x-ray killing (exr^-), and they retain host cell reactivation ability for uv-irradiated T_3 phage ($uv\text{-}hcr^+$). One of them retains the normal host cell reactivation ability for x-irradiated T1 phage ($x\text{-}hcr^+$), but two of them have reduced ability ($x\text{-}hcr^-$). Only two of all the selected mutants have intermediate $uv\text{-}hcr^-$ character. $Uv\text{-}hcr^-$ mutants are also highly sensitive to uv-induction of mutation, but one of the exr^- mutants has the same resistance to uv-induction of mutation as its parent (uvr^+) strain in spite of the uvr^- character for killing. It is suggested that resistance mechanisms for x-ray damage may be largely independent of the well-known excision-resynthesis repair mechanism for damage to pyrimidine dimers and other DNAs. (auth)

36771 SELECTION OF A MATHEMATICAL MODEL OF POST-IRRADIATION RECOVERY OF YEAST CELLS AFTER LETHAL IRRADIATION. Kapul'tsevich, Yu. G. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya, 7: 20-3 (1967). (In Russian).

On the basis of experimental data obtained on irradiation of Saccharomyces cerevisiae with γ rays at a rate of 86 R/sec, the conclusion was reached that the mathematical model for gradual recovery describes more accurately the behavior of yeast after irradiation than that of single-cell recovery. The latter hypothesis, which involves the assumption that a yeast cell is freed within a short time of all radiation injuries irrespective of their number, is inconsistent with experimental results. (JPRS)

36772 ULTRAVIOLET-INDUCED COLICINES OF ESCHERICHIA COLI FROM THE NORMAL HUMAN INTESTINE. Young, Viola M.; Branche, W. C. Jr.; Kenton, Dolores M.; Lee Marcia R. (National Inst. of Health, Bethesda, Md.). J. Pathol. Bacteriol., 92: 303-11(Oct. 1966).

Strains of E. coli were recovered from fecal cultures taken monthly from five persons during a period of 6 months and were exposed to uv radiation to induce the production of colicine. Suspensions of the bacteria were irradiated for 60 sec in a petri dish with a uv source having a principal emission at 2537 Å. Then the cultures were incubated for 3½ and 24 hr at 37°C. Seventy-five of 259 strains exposed to uv radiation yielded induced colicines, whereas 159 of these strains had previously been found to produce colicines without uv induction. Of the uv-induced colicines, 13.9% were active against the parent bacterium; these were from strains recovered from the three individuals whose flora of E. coli was least stable. Fifteen percent of the randomly selected indicator strains of E. coli were sensitive to the induced colicines. One of the indicators was susceptible to 69.3% of the uv-induced colicines, and therefore as sensitive as the known indicator, E. coli strain φ. The uv-irradiated broth cultures incubated for 3½ hr and 24 hr at 37°C in many instances differed in colicinogenic activity. Colicine production was not constant in organisms of the same serotype isolated at different times from the same subject. While colicinogeny appeared to be associated with the ability of some E. coli strains to maintain themselves as dominant residents in the human intestine, colicines produced by induction play an undetermined role in the ecology of the intestinal flora. (BBB)

36773 ONCOGENICITY BY DNA TUMOR VIRUSES: ENHANCEMENT AFTER ULTRAVIOLET AND ^{60}Co RADIATIONS. Defendi, V.; Jensen, F. (Wistar Inst. of Anatomy and Biology, Philadelphia). Science, 157: 703-5(Aug. 11, 1967).

Simian virus-40, polyoma, and LLE46 virus preparations were treated with uv or γ radiation (cobalt-60) in a frozen state. Infectivity and induction of complement-fixing antigen and DNA synthesis declined as a logarithmic function of dose; the latter two properties were more resistant than infectivity to radiation by a factor of 2 to 5. Oncogenicity of all three viruses did not decrease with progressive amounts of both types of irradiation, but actually increased in absolute and relative terms (per infectious unit), even at the maximum dose of radiation used (24,000 ergs per square millimeter per minute and 2.7×10^6 rads). (auth)

Radiosterilization and Radiopreservation

Refer also to abstract 36746.

36774 (JPRS-40968) INSTALLATION FOR THE IRRADIATION OF FOOD PRODUCTS. Translated from Nauka Zhizn', 23: No. 8, 19-20(1956). 7p. (TT-67-31610). CFSTI.

The principal requirements of industrial radiosterilizers and the use of the Van de Graaff accelerator in these devices are discussed. A γ-ray sterilizer with a screw-type conveyor that can be used for prolonged irradiation of potatoes is described. (B.H.S.)

36775 EFFECT OF EXPOSURE TO RADIO-FREQUENCY ELECTRIC FIELDS ON SEED-BORNE MICROORGANISMS. Seaman, W. L.; Wallen, V. R. (Canada Dept. of Agriculture, Ottawa). Can. J. Plant Sci., 47: 39-49(1967).

Exposure of naturally infected and artificially inoculated seeds to rf radiation (59 to 64 Mcps) was of varying effectiveness in eradicating internally borne fungi and bacteria. Diaporthe phaseolorum was eliminated from soybean seeds with little reduction in seed germination. Survival of Ascochyta pisi and A. pinodes (Mycosphaerella pinodes) in field pea seed was greatly reduced by similar treatment, but the fungi were not usually eradicated without appreciable reduction in germination. Germinability of pea seeds was unaffected by increasing the moisture content of the seed to 16% from 10.3%. The A. pinodes content of such seeds, however, was reduced by about 50%. Both seed and fungus were more susceptible to damage by rf treatment at the higher moisture level. Bean seed infected with Xanthomonas phaseoli var. fuscans and cabbage seed inoculated with X. campestris were killed by exposures which reduced but did not eradicate the bacteria. Colonies of both xanthamonads on nutrient agar media were destroyed by rf treatment. (BBB)

36776 BELGIAN WORK ON FOOD IRRADIATION. De Proost, M. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Meded. Landbouwhogesch. Opzoekingssta. Staat Gent, 30: 667-72 (1965). (In French). (BLG-414).

Research work carried out in Belgium on the irradiation of food is reviewed. Studies on the radiopreservation of vegetables and fruit, the disinfestation of food, and the effects of γ radiation on

wheat flour are described. Other studies concerning the wholesomeness of irradiated food are mentioned, and gamma irradiation facilities available in Belgium are listed. (31 references.) (C.H.)

36777 VOLATILE COMPOUNDS PRODUCED BY IRRADIATION OF BUTTERFAT. Merritt, Charles Jr.; Forss, D. A.; Angelini, Pio; Bazinet, M. L. (Army Natick Lab., Natick, Mass.). J. Amer. Oil Chem. Soc., 44: 144-6(Feb. 1967).

Investigations were made of the volatile compounds produced during the irradiation of foods in attempts to determine their roles in flavor and breakdown patterns. Anhydrous butterfat was γ irradiated at 6 Mrad in a special glass reaction flask, and the headspace and total condensate samples were examined by wide-range (−180 to 125°C) gas chromatography combined with mass spectrometry. The nature and amounts of volatile compounds were greatly influenced by whether the butterfat was irradiated under oxygen or under vacuum, nor (apart from n-alkanoic acids) by storage for 1 and 9 weeks. Carbon dioxide was produced in greatest amount. Of the remaining compounds, aliphatic hydrocarbons predominated both in number and amount. Aliphatic oxygenated compounds including carbonyl compounds were isolated in relatively small amounts. The following compounds were identified positively: C_{1-13} n-alkanes; C_{4-9} 2-methylalkanes; C_{2-14} alk-1-enes; C_{2-9} alk-1-ynes; C_{2-5} n-alkanoic acids; C_{1-5} n-alkan-1-ols and propan-2-ol; C_{2-8} n-alkanals and 2-methylbut-2-enal; $C_{3-5,7}$ alkan-2-ones; C_{1-4} n-alkyl formates, vinyl and isoamyl formate, methyl acetate and methyl n-hexanoate; and carbon dioxide. The predominating amounts of hydrocarbons produced by irradiation of butterfat suggests formation of hydrocarbon free radicals from alkyl chains as the primary mechanism involved. (BBB)

36778 RADIATION-HEAT SYNERGISM FOR INACTIVATION OF MARKET DISEASE FUNGI OF STONE FRUITS. Sommer, N. F.; Fortlage, R. J.; Buckley, Patricia M.; Maxie, E. C. (Univ. of California, Davis). Phytopathology, 57: 428-33(Apr. 1967).

Synergistic effects of combined ^{60}Co γ radiation and heat treatments were compared with the single treatments for inactivation of spores of post-harvest pathogens of Prunus spp. Interaction between treatments sometimes caused a 5- to 10-fold increase in inactivation. The amount of synergism and the preferred sequence of application for maximum fungicidal effect depended upon the pathogen. With Rhizopus stolonifer, the maximum effect occurred if irradiation was first. In all other species studied, the reverse sequence resulted in greatest inactivation. Studies with fruit inoculated with Monilinia fructicola demonstrated the advantage of heat sensitization before irradiation in brown rot control. The possibility of obtaining the desired fungicidal effect with comparatively mild treatments is particularly important with irradiation. Reduction of the dose requirement for radiation treatment by half would materially reduce costs. Further, heating may permit the subsequent use of radiation with commodities adversely affected by doses otherwise required. The fact that a fungus species may be sensitive to radiation and resistant to heat probably reflects differences in the lesions inflicted by the two physical processes. Differences in inactivation caused by the sequence of application of heat and radiation in combined treatments evidently reflect qualitative differences in the injury sustained by various fungus species. (BBB)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstract 36302.

36779 (PEL–74) NUCLEAR REACTOR MATERIALS OTHER THAN NUCLEAR FUELS. Nel, L. T. (Atomic Energy Board, Pretoria (Union of South Africa)). [nd]. 63p. Dep.

Information concerning the occurrence and availability of reactor materials in South Africa, their production in comparison with other parts of the world, their selling prices, and their properties and uses in nuclear reactors are discussed. Materials considered are: Al, Be, Bi, B, Cd, Cr, Co, graphite, Hf, He, Pb, Li, Mg, Hg, Mo, Ni, Nb, Ta, rare earths, Na, Ta, Ti, W, V, and Zr. (M.C.G.)

Corrosion and Erosion

Refer also to abstract 38592.

36780 (BM–RI–6998) REACTION OF TUNGSTEN–COBALT ALLOYS WITH OXYGEN AT 1000° AND 1100°K. Doerr, Robert M.; Neumeier, L. A.; Jensen, J. W. (Bureau of Mines, Rolla, Mo. Rolla Metallurgy Research Center). Aug. 1967. 22p. Bureau of Mines Free.

Oxidation behavior of selected W–Co alloys was studied. Specimens of W and W–Co containing 0.7, 1.7, 3.4, and 9.7 wt % Co were subjected to pure O_2 at 1,000 and 1,100°K, and specimens of W–Co containing 29.8 wt % Co, at 1,100°K. Reaction kinetics were determined volumetrically. For specimens other than those containing 29.8% Co, the reactions proceeded at about a constant rate at either temperature, indicating the formation of a scale of constant protectivity; the reaction rates were essentially independent of the Co concentration. The scales on these alloy specimens consisted principally of WO_3 and $CoWO_4$. Specimens of a 29.8 wt % Co alloy, consisting primarily of the W_6CO_7 phase, oxidized with only slight deviations from the parabolic rate law at 1,000°K. The protective scale on these specimens consisted chiefly of Co_3O_4, $CoWO_4$, and $W_{18}O_{49}$; Co_3O_4 was outermost, and the $W_{18}O_{49}$ was adjacent to the alloy. The results suggest that the Co-rich outer scale inhibited the inward transport of O to an extent sufficient to greatly limit the amount of the nonprotective WO_3 formed, so that protective $W_{18}O_{49}$ formed instead. (auth)

36781 (BNL–50054) HIGH-TEMPERATURE LIQUID-METAL TECHNOLOGY REVIEW. A Bimonthly Technical Progress Review. Volume 5, Number 2. (Brookhaven National Lab., Upton, N. Y.). Apr. 1967. 41p. Dep. CFSTI.

Developments are reported for studies on: ultrasonic instrumentation for nuclear applications; refractory metal alloys for service in oxygen-contaminated Na; in-reactor corrosion of jacket and structural materials by Na; liquid-metal heat transfer in double-pipe heat exchangers; incipient-boiling superheats in Na; boiling liquid-metal technology; vanadium alloy screening studies and fabrication of V–15 wt % Ti–7.5 wt % Cr tubing for nuclear fuel cladding; analog simulation of Na-heated steam generator; effects of carbon and carbonate additions in a Na test loop; carbon movement in pumped Na test loop; liquid metal MHD power conversion; mechanism of nucleate pool boiling heat transfer to Na and the criterion for stable boiling; techniques for measurement of impurities in Na; effects of high temperature Na on austenitic and ferritic steels; potassium turbine two-phase flow analysis; magnetic and electrical materials capable of operating in the 800 to 1600°F range; generator developed for SPUR program; ac generator rotor materials. (P.C.H.)

36782 (BNWL–398) PROMETHIUM HEAT SOURCE COMPATIBILITY STUDIES. PART II. METAL–METAL COMPATIBILITY AT 1100°C. Kirby, L. J.; Fullam, H. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1967. Contract AT(45-1)-1830. 16p. Dep. CFSTI.

Metal-metal couples were studied after exposures up to 4000 hr at 1100°C to characterize and evaluate reactions that occurred. The couples studied included: Hastelloy X with Re, Mo–50 Re, W–25 Re, W, and Ta; Ta with Re, W–25 Re, and W; 304L SS with Re, W–25 Re, Mo–50 Re, Ta, Ir, and Pt; Re with Mo–50 Re, W–25 Re, and Pt; and Pt with W–25 Re. In addition, the reactions of Hastelloy X and Hastelloy C with Re, W–25 Re, and Ta were studied following experiments where the temperature was cycled (700 to 1100°C). Hastelloy X and 304L SS reacted with Re, Mo–50 Re, and W–25 Re to form diffusion zones where there was little tendency for the individual metals in Hastelloy X or 304L SS to migrate preferentially. The diffusion zone appeared to approach a limiting thickness in long term tests of the 304L–Re couple. In reactions between Hastelloy X or 304L SS and Ta, Ni tended to concentrate at the Ta-rich side of the diffusion zone. Fe showed a finite but lesser tendency to concentrate at the Ta-rich side, while Cr showed no tendency toward this preferential migration. Ta reacted very slightly with Re, W–25 Re, and W. Pt reacted extensively with Re and W–25 Re, and was totally unacceptable as a liner for 304L SS capsules. Ir behaved similarly with 304L SS. Hastelloy C, studied only in temperature cycling tests with Re, W–25 Re, and Ta, was slightly less reactive than Hastelloy X. When compared with the static tests, the diffusion reactions were generally more pronounced for temperature cycling tests with Hastelloy X. (auth)

36783 (COO–1319–56) A STUDY OF THE MECHANISM OF STRESS CORROSION CRACKING IN THE IRON–NICKEL–CHROMIUM ALLOY SYSTEM. Quarterly Report, December 17, 1966–March 16, 1967. Staehle, R. W. (Ohio State Univ. Research Foundation, Columbus). June 16, 1967. Contract AT(11-1)-1319. 27p. Dep. CFSTI.

Results are reported on stress-corrosion studies at 260 and 289°C, single-crystal tensile flow curves, and dynamically straining electrodes. The autoclave experiments showed that increasing the temperature to 289°C compared to 260°C actually decelerates cracking. The effect is due probably to the rapid growth of an oxide film, which resists slip step emergence. The single-crystal studies show that the presence of an anodically formed oxide film exerts a restraining effect on the emergence of slip steps. Dynamic straining experiments show that the nature of transient currents depends strongly on the rate of slip step emergence and on the region of the flow curve (easy glide vs strain hardening). (auth)

36784 (EURAEC–1757) IMPERFECTIONS IN METALS. II. CORROSION AND OXIDATION. Quarterly Report No. 15, April 1–June 30, 1966. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Contract 054-64-4-TEEB. 17p. (EUR–3312). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The oxide films formed under some different conditions on an AISI 304 stainless steel have been investigated by electron microscopy and electron diffraction. An influence of the electropolishing of the metal surface was noticed as well on the nature as on the morphology of the oxide films. The anomalous behavior of the oxidation at the grain boundary area in precipitation-treated steel foils was hardly detectable in as-treated foils. The reduced oxidation in these areas was only clearly observed in foils electropolished prior to oxidation. However, no difference in composition could be detected between the grain boundary area and the inside of the grain. (auth)

36785 (EURAEC–1850) STUDIES OF STEEL CORROSION IN HIGH TEMPERATURE WATER AND STEAM. Quarterly Report No. 18, January 1–February 28, 1967. (Societe d'Etudes, de Recherches et d'Applications pour l'Industrie, Brussels (Belgium)). May 25, 1967. Contract 087-1-TEEB(RD). 102p. (EUR–3361). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The study of austenitic grades of stainless steel with high recrystallization temperatures was continued to permit exploitation, at temperatures above 500°C, of the improvement produced by suitable surface machining in the corrosion behavior of stainless steels in superheated steam. Although these special grades of steel do not recrystallize at temperatures of the order of 600 to 700°C, their behavior is unfavorable in superheated steam after machining and relatively long annealing at these temperatures. With regard to AISI 304 stainless steel, the H_2 diffusion method confirmed that work-hardening several tens of microns deep is required to ensure good long-term behavior in superheated steam at 500°C. In the wholly recrystallized state, it was found that a special grade of austenitic 18/8 steel containing 0.2% C, 1.5% Si and 4% W is far less corroded in superheated steam at 600 and 700°C than the standard 18/10 grades. Moreover, this grade is far less sensitive to intergranular corrosion in this medium. An extensive corrosion test on 304 steel in superheated steam at 500°C, effected on a capsule specimen under steam pressure, revealed the very serious extension of intergranular attack which occurs in superheated steam for these structurally normal alloys. Microscopic examination of an Inconel 600 capsule treated for 1200 hours in superheated steam at 600°C did not confirm the very marked intergranular attack which had been shown by test-pieces of a similar alloy treated in autoclaves. This behavioral divergence may be due to differences in composition between the two

alloys, which were theoretically identical. A dynamic corrosion test was effected at 250°C in water with LiOH added to keep the pH at 10. The test concerned AISI 304, AISI 410 and CREUSOT 1.2 MD07 steels. It confirmed that maintaining the pH at 10, in a constantly purified system, brings a considerable reduction in the level of corrosion; it also confirmed that the dynamic nature of the tests has only a very secondary effect on the results. Study of a zirconium-2 chromium-0.16 iron alloy in superheated steam at 450°C showed that, after 4,000 hours, electrolytic polishing still has an advantage over pickling or mechanical preparation of the surfaces. In the case of the electrolytically polished specimens, the transition point is reached less quickly and the corrosion rate in the post-transition zone is lower. (P.C.H.)

36786 (EURAEC-1865) [TESTING OF STAINLESS STEELS]. Summary of Quarterly Report No. 9, October-December 1966. (Compagnie des Ateliers et Forges de la Loire, Paris (France). Centre de Recherches). Contract 033-64-9-TEEF(RD). 124p. (EUR-3369). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The behavior of 8 kinds of stainless steel was tested in solutions of $MgCl_2$, NaCl, and $CaCl_2$ under mechanical stress. Tests were also conducted in superheated steam on stainless steel wires under tensile stress. A surface processing, that could considerably increase the resistance to corrosion of Cr plated under gas, is being developed. The stress-corrosion tests emphasized the importance of electrochemical factors and their modification according to the composition and the structure of the steel. General corrosion tests in water at 350°C were also carried out and the austenitic steels seemed to be superior to the austeno-ferritic steels. (M.C.G.)

36787 (LA-3631) HIGH-TEMPERATURE ENVIRONMENTAL TESTING OF LIQUID PLUTONIUM FUELS. Andelin, R. L.; Kirkbride, L. D.; Perkins, R. H. (Los Alamos Scientific Lab., N. Mex.). Jan. 17, 1967. Contract W-7405-eng-36. 24p. Dep. CFSTI.

Equipment for testing containers for liquid Pu alloys at 900 to 1100°C was developed and used. Uncarburized and carburized Ta and Ta-5W capsules were tested with Pu, Pu-Fe, and Pu-Co-Ce. The Pu-Co-Ce alloys were less corrosive than Pu-Fe (10 at.% Fe), which in turn was less corrosive than Pu. Carburization of Ta and Ta-5W containers greatly improved their corrosion resistance to liquid Pu alloys. Carburized Nb-10W and Nb-1Zr alloys were satisfactory containers for Pu-Co-Ce alloys containing 2 g Pu/cm^3. (auth)

36788 (NAA-SR-12447) DYNAMIC MASS TRANSFER OF STAINLESS STEEL IN SODIUM UNDER HIGH-HEAT-FLUX CONDITIONS. Hopenfeld, J.; Darley, D. (Atomics International, Canoga Park, Calif.). July 15, 1967. Contract AT(04-3)-701. 54p. Dep. CFSTI.

Equations governing the corrosion rate of fuel cladding material in Na cooled reactors are presented. Using corrosion data obtained from various loop tests, attempts were made to evaluate the mass transfer coefficients which appear in the basic equations. It was found that available loop data are inadequate to provide the needed information, mainly because the local bulk liquid concentration of the corrosion products cannot be determined to any degree of certainty in these loops. A test loop facility is described where this difficulty is eliminated by setting up concentration gradients between the surface and the bulk liquid by means of high-heat-flux heaters. Preliminary data are presented on the corrosion behavior of type 304 stainless steel exposed to 1200°F Na, with a 1250°F surface temperature. The results obtained demonstrate the feasibility of using the present method to study mass transfer mechanisms in Na. (auth)

36789 (NASA-CR-72257) SNAP-8 MATERIALS REPORT FOR JULY-DECEMBER 1966. (Aerojet-General Corp., Azusa, Calif.). Jan. 1967. Contract NAS 5-417. 47p.

Investigations were conducted in support of the design, fabrication, and development testing of various SNAP-8 components and system loops. Operation of a Hg forced-convection corrosion loop was conducted with the aim of evaluating the corrosion resistance of 9Cr-1Mo alloy steel (the reference Hg containment material) for 10,000-hr service. Data were developed in a continued program to evaluate the effect of the SNAP-8 turbine operating environment on the reference aerodynamic materials. (auth)

36790 (USNRDL-TR-67-64) CORROSION STUDIES OF HAYNES 25 ALLOY IN SEA WATER USING ELECTROCHEMICAL TECHNIQUES. Kubose, Donald A.; Cordova, Herman I. (Naval Radiological Defense Lab., San Francisco, Calif.). May 16, 1967. Contract AT(49-5)-2084. 32p. Dep. CFSTI.

Electrochemical corrosion rate measurements were made on uncoated, emissively coated and thermally shocked and uncoated specimens of Haynes 25 alloy in seawater at room temperature and 90°C. The corrosion rates of the emissively coated specimens were about an order of magnitude higher than those of the uncoated specimens. No significant difference between the corrosion rates measured at room temperature and at 90°C was observed for either the uncoated or the emissively coated specimens. Thermal shocking of uncoated specimens (by quenching from 500°C to room temperature) did not increase their corrosion rates. The corrosion rates observed were on the order of 3×10^{-3} mils per year (mpy) for the uncoated and the thermally shocked uncoated specimens and 4×10^{-2} mpy for the emissively coated specimens. (auth)

36791 CORROSION OF REFRACTORY METALS BY LIQUID BISMUTH, TIN, AND LEAD AT 1000°C. Shimotake, H.; Stalica, N. R.; Hesson, J. C. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 141-2 (June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36792 CAVITATION DAMAGE IN LIQUID-METAL-COOLED REACTOR POWERPLANTS. Garcia, R. (Aerojet-General Corp., Azusa, Calif.); Hammitt, F. G. Trans. Amer. Nucl. Soc., 10: 142-3 (June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36793 ELECTRICAL RESISTIVITY MEASUREMENT TECHNIQUE: TOOL FOR SODIUM-EXPOSED MATERIALS EVALUATION. Bohne, L. H.; Kimont, E. L.; Smith, F. A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 143-4 (June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36794 FISSION-PRODUCT BEHAVIOR IN MOLTEN-SALT REACTORS. Kirslis, S. S.; Blankenship, F. F.; Grimes, W. R. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 155-6 (June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36795 ADSORPTION OF OXYGEN ON TUNGSTEN AT TEMPERATURES FROM 300 TO 850°K. Singleton, J. H. (Westinghouse Research Labs., Pittsburgh). J. Chem. Phys., 47: 73-82 (July 1, 1967).

The adsorption of O_2 has been studied on a polycrystalline W ribbon at temperatures from 300 to 850°K. Two types of W surface structure are distinguishable by their adsorption and desorption behavior. At 300°K, adsorption on either type of surface occurs into a single phase, but, at higher temperatures, to a maximum of ~765°K, additional adsorption occurs, with an energy of activation of ~0.25 eV. This process probably involves a reconstruction of the W surface rather than the adsorption into a pre-existing set of sites. Limited measurements at temperatures between 800 and 1000°K are consistent with the model of a solution process restricted to the surface layers of the W. The removal of adsorbed O_2, in a high-temperature flash, occurs only by oxide evaporation below ~ 1650°K and by evaporation of both an oxide and O_2 above this temperature. (auth)

36796 PROTECTING REFRACTORY METALS AGAINST OXIDATION. Bartlett, Edwin S. Battelle Tech. Rev., 16: No. 8, 3-8 (Aug. 1967).

Behavior of the refractory metals W, Ta, Mo, and Nb and the technology relating to their protection against oxidation are reviewed. Coatings and their characteristics, methods of applying coatings, service environments, reliability of coated refractory-metal systems, and applications are some of the topics discussed. (P.C.S.)

Preparation and Fabrication

Refer also to abstracts 35960, 36201, 36781, 36789, 38585, and 38599.

36797 (AI-CE-46) HEAVY WATER ORGANIC COOLED REACTOR. DEVELOPMENT OF SAP-STEEL PRESSURE TUBE TRANSITION JOINTS FOR THE HWOCR. Supan, E. C. (Atomics International, Canoga Park, Calif. Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Aug. 15, 1967. Contract AT(38-1)-430. 52p. Dep. CFSTI.

The Heavy Water Organic Cooled Reactor (HWOCR) requires a transition joint between the SAP in-core pressure tube and the out-of-core carbon steel piping. A process is described for hot press diffusion bonding of the SAP to Type 347 stainless steel; the carbon steel pipe is subsequently welded to the stainless steel. A thin layer of W is employed at the transition joint interface to prevent

the formation of intermetallic compounds by diffusion during reactor service. The joint geometry and bonding parameters were optimized to provide consistently helium leaktight joints having an efficiency of 75 to 85% at 750°F relative to the tensile strength of SAP tubes. Evaluation of joints included tensile tests, thermal cycling, thermal soaking, and metallographic examination. An organic loop test section assembly was fabricated by flash welding transition joints to a SAP pressure tube. (auth)

36798 (AWRE-O-29/61) FABRICATION OF LITHIUM ROD AND TUBE BY EXTRUSION. Pendry, N. R.; Robertson, P. (Atomic Weapons Research Establishment, Aldermaston (England)). [nd]. 54p. Dep.

Extrusion of Li metal at ambient temperature for the production of both rods and tubes was studied. Effects of pressure on the rate of extrusion and the dimensions of the product were determined. The most suitable and economical design of die was developed by experiment. The difficulty, due to adhesion of Li to the die metal, was surmounted by the development of an extrusion system in which continuous oil lubrication is provided inside the die orifice. (auth)

36799 (BNWL-458) APPLICATION OF SAFEGUARDS TO NUCLEAR FUEL-FABRICATING PLANTS. Anderson, H. J.; Bennett, C. A.; Budd, R. O.; Granquist, D. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1967. Contract AT(45-1)-1830. 44p. Dep. CFSTI.

The three main problems in applying safeguards to nuclear fuel fabricating facilities are: measuring the fuel content of a finished fuel assembly, evaluation of fuel material contained in scrap, and the variations in fuel fabrication processes. It was concluded that, depending on the size of the plant, a resident inspection team of as few as 2 people, working in a carefully regulated plant, provided with calibrated test standards, and having access to independent, reliable, analytical services, could in most cases achieve a diversion detection capability of about 2% for a completed campaign. It was also concluded that periodic inspection, even with the possibility of verifying shipment and receipts, could not detect with high probability the diversion of as much as 5% of the throughput during a campaign even though prompt scrap recoveries were required. (M.C.G.)

36800 (EURAEC-1609) APPLICATION OF THE MOLTEN FLUX PROCESS TO THE WELDING OF VERY THICK PLATES. Quarterly Report No. 4, January 3, 1966–March 31, 1966. (Chantiers de l'Atlantique Saint-Nazaire (France)). Apr. 1, 1966. 9p. (EUR-2822). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The steels studied, austenitic grain evolution during application of the thermal cycle, austenitization studies, dilatometry, and relaxation tests are discussed. (M.C.G.)

36801 (HA-2322) DEVELOPMENT OF SOLID STATE BONDING TECHNIQUES. Progress Report No. 8, January 1967. Long, J. R. (Harvey Engineering Labs. for Research and Development, Torrance, Calif.). Contract NAS8-20384. 20p.

Process techniques are being developed for roll bonding of Be to Be and Be to Ti to produce rib-stiffened panels for space vehicle applications. About thirty simple lap-type samples were prepared and rolled under various conditions. These were made up of thin Be strips 0.070-in. thick to be bonded to heavier Be strips 0.250-in. thick enclosed in steel jackets. They were hot rolled at temperatures from 1500 to 1700°F with reductions of 5 to 15% per pass and total reductions of 20 to 75%. They were given various soaking times between passes and after completion of the rolling process. The samples were visually examined for bonding after removal from the rolled jacket and metallographic examination was made of the transverse section through the bond. Bonding was obtained in samples given 60 to 75% total reduction at 1600 to 1700°F. Although these samples were bonded, little or no recrystallization appeared to have taken place across the mating surfaces and the bond line was readily discerned in the polished section. It is also evident that the thin beryllium piece underwent significant grain growth while little or no grain growth took place in the thicker piece. The other samples, given total reduction less than 60%, separated during opening of the jacket, in cutting of the metallographic samples, or showed voids and obvious separation in the metallographic section. Under conditions explored so far, rolling temperature, reduction per pass, and soaking time after rolling did not seem to be as significant as total reduction in promoting bonding. Delamination of the Be and shear cracking during rolling was encountered in samples that bonded and also in samples that did not bond. The mating surfaces of samples that did not bond or were only partially bonded were discolored despite the gettering action of Zr chips enclosed in the jacket for protection from oxidation. It was concluded that outgassing of the Be occurred, depositing a film of some kind on the surface and that this film contributed to lack of bonding. (auth)

36802 (HA-2327) DEVELOPMENT OF SOLID STATE BONDING TECHNIQUES. Progress Report No. 9, February 1967. Long, J. R. (Harvey Engineering Labs. for Research and Development, Torrance, Calif.). 6p.

Four sample assemblies for bonding Be to Be were prepared and rolled. For these samples, the Be pieces, the steel separators, the Zr, and the steel for the boxes were degassed prior to assembly. This was accomplished by sealing them in a steel box and heating to 1300 to 1400°F for three 20-minute periods while the steel box was continuously evacuated. The jackets for rolling were then assembled and welded except for the loading end. The Be, steel spacers, and Zr were then inserted and the final end weld made. After checking for leaks, the assemblies were evacuated and heated to 1200 to 1300°F for approximately ten minutes and sealed off. Two sets were rolled at 1400°F and two at 1450°F using a 5% reduction per pass. One sample at each rolling temperature was given 40% total reduction and one sample was given 60% total reduction. None of these samples were successfully bonded. The Be pieces either separated completely on opening the rolled jacket or came apart on further machining to prepare metallographic samples. All of the samples were discolored due to oxidation during rolling. Examination of the rolled jackets indicated that they opened by failure of the welds early in the rolling. The jacket assembly is being revised to avoid reoccurrence of such leaks. (auth)

36803 (MLM-1322) BRAZING SUPERALLOYS AND REFRACTORY METALS. Robbins, W. P. (Mound Lab., Miamisburg, Ohio). Mar. 10, 1967. Contract AT-33-1-GEN-53. 125p. Dep. CFSTI.

Fundamental brazing parameters were determined for combinations of nine braze filler metals with eleven parent metals. The fillers were Ag–Cu, Ag–Cu–10% Pd, Ag–Cu–15% Pd, Au–Ni, Mn–Co–Ni–B, Ni–Cr–Si, Cu, V–Nb, and Mo. The parent metals were Ta, Ta–10% W, Nb, Mo, W, Type 304 stainless steel, Haynes 25 Alloy, Hastelloy C, Waspalloys, ThO_2–dispersed Ni, and U–10% Mo. (D.L.C.)

36804 (RFP-962) METALLOGRAPHIC TECHNIQUES FOR VACUUM-CAST ROLLED INGOT BERYLLIUM SHEET. Calabra, Arthur E.; Jackson, Ross J. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Aug. 7, 1967. Contract AT(29-1)-1106. 10p. Dep. CFSTI.

Two techniques developed for the metallographic preparation of vacuum-cast ingot Be sheet are described. Both methods yield metallographically prepared surfaces considered to be of the highest quality. The first method retains inclusions and requires polarized illumination for structural delineation. The second method is an electrolytic swab-etch technique, which yields bright-field delineation of the microstructure; however, inclusions are not retained. Effects that improper preparation can have on the resulting microstructure are considered. (auth)

36805 (RFP-969) ACCELERATED ION PLATING OF SPR-II REACTOR PARTS. Kurtz, Robert G.; Underwood, Clifford B.; Van Vorous, Ted (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Aug. 3, 1967. Contract AT(29-1)-1106. 4p. Dep. CFSTI.

The process used to coat a set of six plates and four rods, which constitute the ^{235}U components of the Sandia SPR-II pulse reactor, is described. Al was deposited on the parts by an accelerated ion process developed by Mattox and Bland. Part-coating jigs were constructed to suit the SPR-II components. (auth)

36806 (RISO-145) JOINING METHODS APPLIED TO SINTERED ALUMINIUM PRODUCTS. Aastrup, P.; Moe, A.; Knudsen, P. (Danish Atomic Energy Commission, Risoe. Research Establishment). Oct. 1966. 24p. (CONF-660626-2). Dep.

From 2nd Bolton Landing Conference, Lake George, N. Y.

A major problem in the joining of dispersion-strengthened materials is to prevent destruction of the specific distribution of dispersed particles and thus avoid a decrease in high-temperature strength. The gas content may be another important factor since the presence of a large amount of gas in the material is likely to result in a porous welding zone. Different welding methods applied to sintered aluminum products are reviewed. Experiments related to the flash welding process and certain types of fusion welding are treated in more detail. SAP-SAP joints of satisfactory high-temperature strength and tightness were made by flash welding. In the special versions of fusion welding, sound joints were obtained by using aluminum as filler material under closely controlled conditions. As a consequence, good joint strength and tightness at elevated temperatures were achieved by these methods when a suitable joint design was used. (DENMARK)

36807 (UCRL-70361) DESIGN CONSIDERATIONS FOR THE PRODUCTION OF MASSIVE DEPOSITS OF ALLOYS BY EVAPORATION FROM MULTIPLE ELECTRON-BEAM-HEATED SOURCES. Bunshah, R. F.; Juntz, R. S. (California Univ., Livermore. Lawrence Radiation Lab.). June 16, 1967. Contract W-7405-eng-48. 40p. (CONF-670618-2). Dep. CFSTI.

From International Vacuum Metallurgy Conference, New York.

The production of massive alloy deposits of uniform composition and thickness by electron beam evaporation techniques is discussed. The variables of experimental geometry were explored, and one possible solution to make the process technically and economically feasible and attractive is proposed. This solution consists of multiple-beam evaporation from trough-shaped crucibles placed in a radial direction symmetrically with respect to the rotating substrate which should be placed as close as possible to the crucibles to increase collection efficiency. It is hoped to confirm this experimentally. Some work with metals is reported. (auth)

36808 FISSION-FRAGMENT RECOIL ENERGY SOURCE AND CHEMONUCLEAR FUEL ELEMENT. Steinberg, Meyer; Tucker, Walter; Farber, Gerald (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 10: 44-5(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36809 DEVELOPMENT AND FULL-SCALE TESTING OF PROCESS EQUIPMENT FOR THE THORIUM-URANIUM RECYCLE FACILITY. Haws, C. C. Jr.; Snider, J. W. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 95-6(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36810 METHOD FOR SOLDERING GRAPHITE TO METALS. Bellemann, H. (Kernforschungszentrum, Karlsruhe, Ger.). Rev. Sci. Instrum., 38: 1328-9(Sept. 1967).

A method of soldering graphite to metals for use in cyclotron parts, such as beam stops, targets for measuring beam current, and parts of ion sources, is reported. The procedure consists of electroplating the graphite part with Cu and soldering the Cu layer to the metal. (L.B.S.)

36811 INVESTIGATION OF THE STRUCTURE AND PROPERTIES OF A ROLLER FOLLOWING HOT ROLLING OF MOLYBDENUM IN A VACUUM. Gurevich, Ya. B.; Zarapin, Yu. L.; Krupin, A. V.; Orzhekhovskii, V. L.; Osipov, V. G.; Strukova, N. S.; Tylkin, M. A.; Chernyshev, V. N. (Central Scientific-Research Inst. of Ferrous Metals, Moscow). Metalloved. Term. Obrab. Metal., No. 6, 62-6(June 1967). (In Russian).

Hot-rolling of Mo in 5×10^{-5} mm Hg vacuum at 1500 to 1000°C exhibited an adhesion of the deformed metal to the instrument resulting in surface defects. As the temperature of the rollers reached 600 to 700°C and the 40 μ-deep surface reduced on HV 70 and 50, the upper layer became a twisted sorbent layer. Rollers made from ChNVMF steel were found to be the best suited for high-melt materials in a vacuum. (R.V.J.)

36812 HOT-LAMINATION OF METALLIC URANIUM AND URANIUM-ALUMINIUM ALLOY. Liscia, A.; Trittoni, E. (CNEN, Saluggia, Italy). Met. Ital., 59: 371-6(May 1967). (In Italian).

Experiments set up for the lamination of U ingots to obtain rolled sections 1 mm thickness and sheets (thin sections) down to 0.03 mm thickness are described. Various phases of the operations, such as heat treatment in salt bath, hot lamination, and the techniques of sandwich lamination are reported. Finally, the experiments made for the preparation of U-Al alloy laminations and colaminates of Al with a core of U-Al alloy are described. (auth)

36813 MANUFACTURE OF PLATE TYPE FUEL ELEMENTS FOR RESEARCH REACTORS. Colombi, G.; Gabaglio, M.; Liscia, A.; Trittoni, E. (CNEN, Saluggia, Italy). Met. Ital., 59: 359-63(May 1967). (In Italian).

A preliminary evaluation of the experience of MTR fuel element manufacture at CNEN's Saluggia Laboratory for the manufacture and control of fuel elements is given. The manufacturing process is generally well known. The experiments setting up various phases are illustrated followed by a cost account of the manufacturing yield and labor used comparing the results of two series of operations carried out a year apart. (auth)

36814 THE TECHNOLOGY OF COEXTRUSION IN THE MANUFACTURE OF TUBULAR FUEL ELEMENTS FROM METALLIC URANIUM-ZIRCALOY. Boccalari, M.; Colombi, G.; Gabaglio, M.; Liscia, A. (CNEN, Saluggia, Italy). Met. Ital., 59: 328-32(May 1967). (In Italian).

A method for the manufacture of tubular fuel elements in metallic uranium-Zircaloy based on the coextrusion technique starting from a composite billet is described. The results are evaluated. (P.C.H.)

36815 EFFECT OF MOLYBDENUM ADDITION ON THE PROPERTIES OF A NEW MAGNET ALLOY MALCOLLOY IN THE Co-Al SYSTEM. Masumoto, Hakaru; Kobayashi, Takeo; Watanabe, Kiyoshi (Research Inst. of Electric and Magnetic Alloys, Sendai). Trans. Jap. Inst. Metals, 8: 8-13(Jan. 1967).

A new magnet alloy "Malcolloy" having a high coercive force, was examined to determine the effect of Ni additions on its properties; the highest coercive force thus obtained being 1500 Oe. The The effect of Mo addition on the properties of Co-Al alloys, was studied and found that the coercive force of the alloys increases generally by the addition of Mo. An alloy containing 80.51% Co, 13.96% Al and 5.53% Mo shows a coercive force of 1600 Oe, a residual magnetic flux density of 2750 G and maximum energy product of 1.34×10^6 G·Oe, when tempered at 600°C for 20 hr after water-quenching from 1380°C. These alloys consist of many ferromagnetic elongated particles about 400 Å in mean dia which are dispersed in the matrix of a nearly nonmagnetic β' phase. It may be concluded that the high coercivity of these alloys is mainly due to the presence of the fine particles of a single magnetic domain. (auth)

36816 DEVELOPMENT OF PROCEDURES FOR WELDING HY-130(T) STEEL. Connor, L. P.; Rathbone, A. M.; Gross, J. H. (United States Steel Corp., Monroeville, Pa.). Weld. J. (N. Y.), 46: 309s-321s(July 1967).

In 1964, a high-toughness 5Ni-Cr-Mo-V constructional alloy steel with a yield strength in the range 130 to 150 ksi was developed and subsequently designated HY-130(T). Differing from past experience with other constructional alloy steels such as T-1 and HY-80, the results of the procedural study of HY-130(T) weldments indicated that control of the welding parameters would be dictated primarily by the response of the weld metal rather than by the response of the base plate. Radiographic inspection indicated that all test weldments were free of heat-affected-zone cracks. Similarly, no transverse, delayed weld-metal cracks were detected in weldments fabricated from gas metal-arc filler metals containing no more than 3 ppm H_2 or from shielded metal-arc electrodes containing no more than 0.10% moisture. Investigations reveal that a relatively broad range of welding conditions exists within which satisfactory gas metal and shielded metal-arc weldments of HY-130(T) steel can be fabricated to a minimum yield strength of 130 ksi, and that a narrower, but practical, range exists within which gas metal weldments can be successfully fabricated to a minimum yield strength of 140 ksi. (J.R.D.)

36817 PRODUCTION AND INSPECTION OF THE PURITY OF TUNGSTEN AND MOLYBDENUM SINGLE CRYSTALS. Kapustin, V. D.; Belomyttsev, Yu. S.; Bykov, V. N.; Mikhailov, N. N.; Tsoi, V. S. Izv. Akad. Nauk SSSR, Metal., No. 2, 71-8 (Mar.-Apr. 1967). (In Russian).

Using a stream of electrons which produce a narrow molten zone, single crystals 3 to 7 mm in diameter and 200 mm long were produced from powdered metal W and Mo bars 6 and 8 mm in diameter and 300 mm long. An electric torsion balance was used for measuring the resistivity of the resultant crystals at room temperature and at liquid He temperatures. Data are given for the ratio of resistivity at 293°K to that at 4.2°K as a function of the number of remelting passes. It was found that this ratio increases with the number of zone passes. A saturation tendency is observed after three zone passes for W, i.e., the resistivity ratio no longer increases sharply with the number of passes. No such tendency was observed in Mo. The increase in $\alpha = \rho_{293}/\rho_{4.2}$ indicates an increase in the purity of the metal as the number of remelting passes is increased. The values of α were higher for W than for Mo, and specimens cut from the centers of the powder metal rods showed higher α than those cut from the ends. This is apparently due to the fact that the center of the rod was held for a longer time at high temperatures and that refining took place chiefly through degassing, distillation of volatile impurities, and to a lesser degree through displacement of impurities to the molten zone. Considerable quantities of metal were evaporated, depending on the rate of motion of the molten zone and on the number of passes, maximum weight losses being 46% for W and 63% for Mo. No appreciable changes in weight loss or α were observed with an increase in diameter from 6 to 8 mm. An investigation of mechanical properties showed a reduction in hardness and an increase in ductility with an increase in the number of zone remelting passes. (ATD)

36818 RECRYSTALLIZATION BEHAVIOR AND BRAZING OF THE TZM MOLYBDENUM ALLOY. Stone, L. H.; Freedman, A. H.; Mikus, E. B. (Northrop Corp., Hawthorne, Calif.). Weld. J. (N. Y.), 46: 299s-308s(July 1967).

Brazed Mo alloy honeycomb configurations were developed for

structural and heat shield applications at 2500 to 3000°F. Brazing processes were developed for the TZM (Mo–0.5 Ti–0.08 Zr) alloy which allow joining at relatively low temperatures, but which develop high remelt and service temperatures. The most promising method for developing high remelt temperatures involved reaction of a braze alloy with the base metal during the brazing cycle and during a post-braze diffusion treatment at low temperatures. Effects of various thermal exposures on recrystallization and ductility of TZM sheet and foil were studied to establish maximum thermal processing exposures which would still provide acceptable ductility. Recrystallization behavior was correlated with a time-temperature parameter for single as well as multiple thermal exposures. Transverse guided-bend transition temperature tests indicated that the TZM alloy was not significantly embrittled by recrystallization alone. Serious embrittlement was produced only by thermal exposures which resulted in recrystallization and grain growth. A Ti–25 Cr–3 Be braze alloy, which exhibited a liquidus temperature of 2030°F, was most promising for brazing TZM honeycomb structures. Maximum processing temperature required for this alloy was 2300°F. An optimized post-braze diffusion treatment was established by a study of base metal recrystallization kinetics and braze alloy-base metal diffusion kinetics. Ductile, closed-cell honeycomb panels were produced which exhibited remelt temperatures of 3100°F and service capabilities at 2900°F. Applicability of the Ti–25 Cr–3 Be braze alloy and associated processing parameters was also demonstrated on complex edge-attachment joints. (auth)

36819 FLOW STRESS OF BODY-CENTERED CUBIC METALS: INHERENT LATTICE HARDENING OR SOLUTION HARDENING. Fleischer, R. L. (California Inst. of Tech., Pasadena). Acta Met., 15: 1513-19 (Sept. 1967).

Various possible sources were examined for the high strength at low temperature of the common refractory bcc metals. Of the two most likely possibilities, lattice hardening and impurity hardening, the former can unambiguously be shown not to be controlling in certain cases, while an impurity-hardening model describes in considerable detail the experimental results in a wide variety of materials. The distinguishing feature of the defects to which hardening is attributed is that they produce large, asymmetrical distortions which interact strongly with mobile dislocations. (auth)

Properties Evaluations

Refer also to abstracts 36781, 36863, 36866, 38456, and 38660.

36820 (AI-CE-27) HEAVY WATER ORGANIC COOLED REACTOR. SCREENING TESTS OF HYDROGEN DIFFUSION BARRIERS FOR ZIRCONIUM. Kerr, W. R. (Atomics International, Canoga Park, Calif. Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Aug. 15, 1967. Contract AT(38-1)-430. 34p. Dep. CFSTI.

Screening tests in gaseous H_2 were conducted at 399°C (750°F) to determine the efficacy of hydrogen barrier coatings for Zr alloys for use in Heavy Water Organic Cooled Reactor (HWOCR) organic coolant. Plasma-sprayed Al coatings were extremely porous and hence ineffective. ZrO_2, ZrN, and diffused Al coatings were effective H_2 barriers but subject to progressive, catastrophic failure because of their inherent brittleness. It was concluded that further investigation should consider primarily a ductile coating, such as pure Al, or coatings that can be continuously repaired in service, such as oxide coatings. (auth)

36821 (COO-841-10) DIFFUSION STUDIES IN LIQUID METALS. Progress Report, June 1, 1966–May 15, 1967. Swalin, R. A. (Minnesota Univ., Minneapolis. School of Mineral and Metallurgical Engineering). May 15, 1967. Contract AT(11-1)-841. 16p. Dep. CFSTI.

Measurements are being made as a function of temperature and pressure of the radial distribution function, electric resistivity, and atomic diffusivity for liquid Na. Solute diffusion in Ag is also being studied. The electric resistivity of Na at 97.8 to 350°C was a linear function of temperature. The diffusion of Ru, Fe, and Co in liquid Ag was measured. High-pressure apparatus was constructed and complete data were collected of the scattered x-ray intensity as a function of angle for Na. (M.C.G.)

36822 (GA-7968) THERMODYNAMICS OF ADSORPTION OF MIXED METALLIC ELEMENTS ON GRAPHITE AT HIGH TEMPERATURE. Norman, J. H.; Zumwalt, L. R.; Staley, H. G. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). May 5, 1967. Contracts AT(04-3)-633; AT(04-3)-167. 12p. (CONF-670913-2). Dep. CFSTI.

From Symposium on New Investigations in Thermodynamics, Thermochemistry, and Transport Properties, Heidelberg, Germany.

Studies were made on the vaporization of Sr and Ba from TS-688 graphite and Ba from HLM-85 graphite using the Knudsen cell mass spectrometric method. Freundlich equations were derived for the studies. Attempts were made to describe a monolayer in three ways. The theory of mixed species behavior is also discussed. (P.C.H.)

36823 (IITRI-578-P27-22) YIELD PHENOMENA AND FRACTURE OF HYDRIDED ZIRCONIUM. Summary Report, September 1, 1965–August 31, 1966. Broverman, I. (IIT Research Inst., Chicago, Ill.). May 31, 1967. Contract AT(11-1)-578. 46p. (IITRI-B6035-22; EURAEC-1876). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The relations between yield point and strain-hardening coefficient of high-purity polycrystalline Zr (0.005 to 0.009 mm average grain diameter) with temperature (–200 to +200°C) were investigated. The yield point consistently appeared with increasing temperature, provided that the grain size was favorable. The results accentuated the first-order importance of fine-grain size in yield point occurrence. Also, the smaller-grain size was accompanied by a lower strain-hardening coefficient. For each grain size, however, the strain-hardening coefficient was statistically constant with varying temperature. The effects of temperature are explained on the basis of the viscous behavior of grain boundaries relative to grain size. By means of dynamic transmission electron microscopy dislocation behavior was observed in relatively fine-grained (~0.005 mm) and coarse-grained (~0.008 mm) zirconium. The effect in each material of air cooling vs water quenching from the final annealing temperature was also investigated. Considerably less dislocation generation, mobility, and interactions were found resulting from applied external stress in fine-grained material and/or in the air-cooled condition. The results supported the dynamic dislocation concept (Johnston-Hahn model) for the yield point phenomenology. The lower strain-hardening coefficient accompanying smaller grain size and/or slow cooling rate from the final annealing temperature was a manifestation of these same structural effects. (auth)

36824 (IITRI-578-P29-14) RESEARCH ON ZIRCALOY BRAZE ALLOY DEVELOPMENT. [Quarterly Report], April 1–June 30, 1967. Kizer, D. E.; Saperstein, Z. P. (IIT Research Inst., Chicago, Ill.). July 17, 1967. Contract AT(11-1)-578. 6p. (EURAEC-1891). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Most of the original braze alloy candidates have been screened for brazability and corrosion resistance in superheated water. More than 15 alloys appear promising based on these results. Six of the new alloys displayed good corrosion resistance: Pt–3.5 B, Pt–3Si, Pt–4.2Si, Zr–20Co–10Mo, Zr–15Au–15 Mo, and Zr–25Cr–25Sn. The zirconium-base binaries continued to show excellent corrosion resistance after 1500 hr exposure. Preparations have been made for dynamic loop testing of the better alloys. (P.C.H.)

36825 (NP-16857) [HIGH PURITY Be ALLOY SHEET]. Bi-Monthly Progress Report, April–May 1967. (Beryllium Corp., Reading, Pa.). July 10, 1967. Contract NOw-66-0563-c. 3p.

Mechanical tests established that the room temperature tensile and yield strengths of Be–Cu sheet in the as-rolled condition increased as the rolling temperature was decreased from 1400 to 480°F, with the 1.0% Cu alloy usually showing higher strength levels than the 0.008% Cu. Attractive strength levels were developed by rolling the 0.008% Cu alloy at 600°F. Annealing resulted in a substantial decrease in yield strength. Specimens annealed at 1200°F for 48 hr were bend tested. The results indicated that the addition of 1.0% Cu to Be decreased the bend ductility. (P.C.H.)

36826 (NP-16880) SUPPLEMENT TO SELECTED VALUES OF THERMODYNAMIC PROPERTIES OF METALS AND ALLOYS. [1967]. 117p.

Thermodynamic properties and phases and structures are given for various metals and alloys. Data are given for: Eu, Fe, Sm, Th, Tm, U, Zr, Ag–Zr, Al–Th, B–Zr, Be–Zr, Bi–Th, C–Mn, Cd–Pb, Cr–Ni, Cr–V, Fe–V, Hg–Th, In–Zr, Mg–Th, Nb–Zr, Pb–Sn, Pb–Th, Sb–Zr, Si–Th, Si–Zr, Sn–Zr, Th–Zn, and Ti–Zr. (P.C.H.)

36827 (NP-16907) BIBLIOGRAPHY ON THE HIGH-TEMPERATURE CHEMISTRY AND PHYSICS OF MATERIALS IN THE CONDENSED STATE. Volume 1967, Number 2, April–June 1967. Diamond, J. J. (ed.) (National Bureau of Standards, Washington, D. C. International Union of Pure and Applied Chemistry. Commission on High Temperatures and Refractories). 67p.

References (708) are given to journals and books published during 1966 and part of 1967. The subjects covered included:

devices for achieving and measuring and controlling temperatures above 1500°C; devices for physical measurements above 1000°C; properties of metallic, non-metallic, and mixed materials below 1000°C; phase equilibria; and reactions at temperatures above 1000°C. (P.C.H.)

36828 (ORNL-P-3228) DEPENDENCE OF THE MOESSBAUER ISOMER SHIFT ON THE DEGREE OF SPATIAL ORDER FOR COPPER GOLD ALLOYS. Huray, P. G.; Roberts, Louis D.; Thomson, J. O. (Oak Ridge National Lab., Tenn. Tennessee Univ., Knoxville). [1965]. Contract W-7405-eng-26. 10p. (CONF-670812-1). Dep. CFSTI.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif.

A study of the electronic charge of the individual alloy atoms as a function of the degree of order was made for Cu_3Au. The isomer shift of the Moessbauer effect was used to study the charge density near the nucleus. (M.O.W.)

36829 (ORNL-P-3230) HYPERFINE STRUCTURE COUPLING TO ^{197}Au IN Au_2Mn AS A FUNCTION OF PRESSURE. Thomson, J. O.; Huray, Paul G.; Patterson, D. O.; Roberts, Louis D. (Oak Ridge National Lab., Tenn. Tennessee Univ., Knoxville). [nd]. Contract W-7405-eng-26. 11p. (CONF-670812-2). Dep. CFSTI.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif.

Moessbauer measurements on ^{197}Au in the intermetallic compound Au_2 Mn are used to determine the hyperfine structure. The measurements are made as a function of increasing pressure. (M.O.W.)

36830 (ORNL-TM-708) A SURVEY OF THE COMPATIBILITY OF SOME POTENTIAL REFRACTORY-METAL FUEL CLADDING MATERIALS WITH POTASSIUM. DiStefano, J. R.; Hoffman, E. E. (Oak Ridge National Lab., Tenn.). Dec. 13, 1963. Contract W-7405-eng-26. 22p. Dep. CFSTI.

A brief review is presented on the available data on the compatibility of some potential fuel element cladding materials with liquid K. Two of the materials being considered for this type of application are Nb or Mo alloys, and interactions of these materials with K are discussed. It was concluded that from the viewpoint of compatibility, Mo would probably be better than Nb as a potential fuel element cladding material for use in a K–stainless steel system. Isothermal, static test results showed no significant corrosion of Nb and Mo alloys in K at temperatures as high as 1000°C. No tendency for Mo to pick up significant quantities of O_2 was observed in tests conducted up to 1000°C. (P.C.H.)

36831 (ORO-3108-23) UNIFIED THEORY OF STAGES II AND III OF WORKHARDENING IN PURE FCC METAL CRYSTALS. Kuhlmann-Wilsdorf, D. (Virginia Univ., Charlottesville. School of Engineering and Applied Science). Nov. 1966. Contract AT(40-1)-3108. 51p. (CONF-661031-4). Dep. CFSTI.

From American Society for Metals, National Metal Exposition and Congress, Chicago, Ill.

A unified theory of the stress-strain curve of fcc metal crystals in stages II and III is presented. The theory is consistent with the earlier mesh-length theory of stage II hardening but incorporates a dislocation model. Due to their long-range stresses, dislocations must rearrange towards sub-boundary configurations whenever the dislocation density exceeds some critical value. This leads to the establishment of dense dislocation networks embedded in regions of substantially smaller dislocation densities. In stage II, the total area of such dense tangles per unit volume increases progressively, while at the same time, by the principle of similitude, the whole dislocation pattern shrinks in scale. Gradually, the resultant structures develop into well-defined cells surrounded by subboundaries, the interiors of which are virtually free of dislocations. When this stage is reached, the further increase in the area of incipient or completed sub-boundaries per unit volume either ceases completely or at least is greatly slowed down. In both stages, the mean free dislocation path extends between neighboring dense dislocation tangles on the slip plane, while the temperature-independent part of the flow stress is governed by the stress necessary to bow out the longest dislocation links so as to generate new dislocations. Thus the flow stress is a roughly quadratic function of the dislocation density. The theory accounts for the shape of the stress strain curve and the empirical relationship between θ_{II}, τ_{III} and the parabola parameter in stage III. The value of τ_{III} is dependent on the stacking fault energy since this governs the mobility of dislocations normal to their slip planes, without which no sub-boundaries can form. The theory predicts some deviation of stage II from linearity, which is in good agreement with relevant experiments. All geometrical parameters appearing in the theory can be assigned unambiguously. The theory was compared to the experimental evidence and no difficulties and inconsistencies were discovered. (auth)

36832 (ORO-3109-5) A STUDY OF THE ADSORPTION OF OXYGEN ON COPPER (110), (100), AND (111) SURFACES WITH LOW-ENERGY ELECTRON DIFFRACTION. Report No. MS-3935-105-67U. Simmons, Gary W.; Lawless, Kenneth R. (Virginia Univ., Charlottesville. Research Labs. for the Engineering Sciences). May 1967. Contract AT(40-1)-3109. 175p. Dep. CFSTI.

The structural changes observed for clean Cu (110), (100) and (111) surfaces when exposed to low pressures of O_2 are tabulated. All reactions were observed to take place at room temperature unless noted otherwise. The initial structural features, as observed in the diffraction patterns, were preceded by increase in background intensities. A qualitative determination of the relative reaction rates for each of the (110), (100) and (111) surfaces can be made from the O_2 exposures required to produce observable changes in the LEED patterns. This kinetic data, together with the structural changes in these surfaces, suggest a reasonable mechanism for the interaction of oxygen with copper. Noticeable increases in background intensities were observed for the (100) and (111) surfaces before any new features became apparent. For the (110) surface, a one-dimensional ordered structure was found to precede the formation of a specific adsorption structure. Very weak and diffuse spots were observed following the increases in incoherent scattering and prior to the formation of well-defined diffraction patterns. The weak reflection found for the Cu(111) surface were attributed to a monolayer of 0^{-2} ions. The weak "four-spot" pattern observed for the (100) surface may have been indicative of a similar 0^{-2} layer. The rate of appearance in background intensity, as well as the formation of weak reflections, occurred in the order of (110) > (100) > (111). The rate of formation of the well-defined surface structures exhibited an identical order of reactivity. (77 references). (auth)

36833 (UCID-15176) HIGH-TEMPERATURE PROPERTIES OF LIQUID METALS. Space Power Note No. 227. Watts, J. L. (California Univ., Livermore. Lawrence Radiation Lab.). July 21, 1967. Contract W-7405-eng-48. 61p. Dep. CFSTI.

A library search and parameter compilation was carried out in order to obtain the temperature dependent parameters of vapor pressure, vapor density, liquid density, heat of vaporization, surface tension, liquid viscosity, and vapor viscosity for the liquid metals Li, Na, K, Rb, Cs, and Ag over the vapor pressure range from 10^{-2} (10^{-3} for Cs) to 10 bar. (auth)

36834 (UCRL-17215) MICROSTRUCTURE AND PROPERTIES OF METASTABLE AUSTENITIC HIGH-STRENGTH STEELS. Dunning, John S. (California Univ., Berkeley. Lawrence Radiation Lab.). Dec. 1966. Contract W-7405-eng-48. 42p. Dep. CFSTI.

Thesis.

Effects of composition and thermal-mechanical treatment on the structure and properties of metastable austenitic steels were studied. Two topics considered were: the cyclic quenching of austenite where the transformation of austenite is accomplished thermally and the composition dependence of transformation-induced plasticity where strain-induced transformation occurring during tensile testing favors superior ductilities. The cyclic quenching of deformed austenite was effective in producing a fine martensite plate size and the fineness of the microstructure resulted in high strengths. Optimum strength–ductility ratios were obtained after two or three cycles of quenching and tempering. The strain-induced austenite-to-martensite transformation was utilized in a simple Fe–Ni–Mo–C alloy to produce enhanced ductilities. The occurrence of the strain-induced transformation during tensile testing was related to the percentage of martensite present prior to testing. (auth)

36835 (UCRL-70570) CALCULATIONS OF THE DYNAMIC STRENGTH OF A MATERIAL. Wilkins, Mark L. (California Univ., Livermore. Lawrence Radiation Lab.). July 26, 1967. 8p. (CONF-670914-11). Dep. CFSTI.

For Presentation at International Symposium on the Behavior of Dense Media Under High Impulsive Pressures, Paris, France.

A model of the dynamic behavior of materials was formulated, which describes relaxation effects. Physical assumptions are taken from dislocation theory. The model is used with computer programs that calculate non-steady flow in one and two space dimensions. (auth)

36836 (UUIP-527) APPLICATION OF THE MORSE FUNCTION TO CLEAVAGE. Vingsbo, Olof (Uppsala Univ. (Sweden). Inst. of Physics). Apr. 1967. 20p. Dep.

A modified Morse function is suggested to describe the cleavage of cubic metals. The function is based on the surface energy of the

crystal. This quantity is calculated for a number of cubic metals, using the Morse function parameters derived by Girifalco and Weizer. The suggested function gives an expression for the theoretical cleavage stress, and predicts anisotropic cleavage properties in reasonable agreement with experimental observations. (auth) (SWED)

36837 THE SOLUBILITIES OF SELECTED GROUP-V ELEMENTS IN LIQUID PLUTONIUM. Bowersox, D. F.; Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 10: 106(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36838 CREEP–STRAIN PREDICTION FOR RADIOISOTOPE HEAT-SOURCE CAPSULES. Mullendore, A. W.; Stein, Charles (Sandia Corp., Albuquerque, N. Mex.). Trans. Amer. Nucl. Soc., 10: 118-19(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36839 DEVELOPMENT OF HIGH-STRENGTH VANADIUM-BASED ALLOYS FOR LMFBR CORE APPLICATIONS. Pollack, W. (Westinghouse Astronuclear Lab., Pittsburgh); Bishop, E. C.; Begley, R. T.; Buckman, R. W. Trans. Amer. Nucl. Soc., 10: 119-20(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36840 LOW-CYCLE FATIGUE PROPERTIES OF IRRADIATED HAFNIUM. O'Donnell, W. J.; Weinberg, J. G. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 10: 138(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36841 HEAT CAPACITY OF SCANDIUM FROM 1 TO 23°K. Flotow, Howard E.; Osborne, Darrell W. (Argonne National Lab., Ill.). Phys. Rev., 160: 467-71(Aug. 15, 1967).

The heat capacity C_p of a well-characterized, polycrystalline Sc sample was measured from 0.9 to 23°K. The results are in reasonable agreement with previous measurements below 4°K, except that a small anomalous addendum to the heat capacity was detected, which is believed to be due to small concentrations of magnetic impurities in the sample. The results below 8.4°K after correction for the effect of impurities could be represented by the equation $C_p = \gamma T + (12R\pi^4/5)\,(T/\Theta)^3$, where $\gamma = 10.66 \pm 0.10$ mJ deg^{-2}(g-atom)$^{-1}$ and $\Theta = 359.5 \pm 4.2$°K. A table of smoothed heat capacities and thermodynamic functions for Sc at selected temperatures between 5 and 298.15°K is presented. (auth)

36842 FORMATION OF METAL FILAMENTS AND THEIR CHARACTERIZATION. Ross, J. H. (Air Force Materials Lab., Wright-Patterson Air Force Base, Ohio). J. Polym. Sci., Part C, No. 19, 105-16(1967).

A technique was established for the drawing of bundles of sheathed superalloy wires. Reduction of the individual filaments to a final diameter of 0.0005 in. was accomplished for Chromel R and René 41 with as many as 100 filaments per bundle. The problems of sheathing, stress-relieving, and desheathing were solved. However, the problem of interfilament welding and/or oxide bonding still requires extensive explanation, first, to define more clearly the causes of welding or bonding; second, to develop techniques for separating the welds or bonds, and third; to accomplish this with a minimum of loss in strength and elongation while achieving the flexibility and bending recovery of yarns formed by stranding single-drawn superalloy fibers. The successful achievement of these goals will yield high strength, flexible superalloy yarns capable of being woven and fabricated, systems requiring the thermal stability provided by superalloys. (auth)

36843 KINETICS OF OXYGEN CHEMISORPTION ON THE SURFACE OF THIN MOLYBDENUM LAYERS. Lazarov, D. (Sofia Univ.). Compt. Rend. Acad. Bulg. Sci., 19: 41-4(1966).

The kinetics of O_2 chemisorption on the surface of thin Mo layers was investigated. The Elovich equation was widely used for processing the data obtained in analyzing the kinetics of gas adsorption on the surface of thin metal layers. Thin Mo layers were obtained by evaporation and subsequent condensation in an apparatus allowing a vacuum of 10^{-6} to 10^{-7} mm Hg. After a 2-hr heat treatment at 400°C, the layer displayed a stable resistance, which changed linearly and reversibly with the temperature. The process was carried out at a constant O_2 pressure in the working section of the vacuum apparatus. Investigations showed the possibility of finding physicochemical characteristics for the kinetics of chemisorption processes on the surface of thin metal films. However, the results can be considered absolutely correct only in the case when the relationship between the amount adsorbed and the changes in the layer's resistance is actually linear and is not significantly affected by temperature. (JPRS)

36844 PROMISE OF PLUTONIUM. Pardue, William M. Battelle Tech. Rev., 16: No. 8, 19-23(Aug. 1967).

Evaluation of Pu as a fuel for power-generating plants shows its potential to be greater than U for both present and future uses. Difficulties in realizing this potential are discussed; including handling, fabrication, cost, and other problems. The state of Pu technology is reported. (P.C.S.)

36845 CONTRIBUTION TO THE STUDY OF URANIUM ALLOYS WITH LOW VANADIUM ADDITIONS. Reisse, R.; Collot, C.; de Lamer, C.; Guillaume, C.; Francois, D. (Centre d'Etudes de Bruyeres-le-Chatel, France). Mem. Sci. Rev. Met., 64: 453-66(May 1967). (In French).

The kinetics of the $\beta \rightarrow \alpha$ transformations of the U–0.20% V were studied by continuous cooling and isothermal quenching. In connection with the different types of structures obtained, the mechanical properties of the alloy were determined at room temperature. Property changes in the range from 25 to 600°C were also studied. (tr-auth)

36846 CONTRIBUTION TO THE STUDY OF WORKHARDENING AND RECOVERY OF MOLYBDENUM AND TUNGSTEN. Touboul, J.-P.; Lhomme, P.-J.; Le Hericy, J.; Langeron, J.-P. Mem. Sci. Rev. Met., 64: 489-98(May 1967). (In French).

Initially workhardened Mo was found to be best for rolling. Further deformation under heat eliminated certain point defects which changed the resistivity but not the hardness (about 150°C for Mo and 350°C for W). At the second stage (600°C for W) recovery was directly related to re-arrangement of the dislocations. (auth)

36847 STACKING FAULTS IN TUNGSTEN. Demny, J. (Brown, Boveri and Cie AG, Heidelberg). Phys. Status Solidi, 22: K1-2(July 1, 1967).

Electron microscopy was used to study stacking faults in W. The faults were formed by an electrical discharge in the illuminating system of the electron microscope during observation. (M.O.W.)

36848 SUPERFICIAL BORONATION OF ZIRCONIUM. Vuillard, Guy (ONERA, Chatillon-sous-Bagneux, France); Walder, Andre. Rev. Int. Hautes Temp. Refract., 4: 29-37(Jan.-Mar. 1967). (In French).

Thermal decomposition of BCl_3 on Zr heated with H_2 and Ar to about 1050°C generates a very compact and adherent B layer. This layer increases regularly by nearly 50 μ in one hour. This diffusion of B into Zr is very slow. Between 1000 and 1400°C the diffusion parameters are approximately determined by depths of penetration. The superficial boronation forms a very hard layer, tightly gripped in the metal. (auth)

36849 THE CHARACTERISTICS AND THE METHODS OF TEST OF THE STRUCTURAL MATERIALS IN RELATION TO THE WAYS OF USE IN REACTORS. Montagnani, M. (CCR-EURATOM, Ispra, Italy). Met. Ital., 59: 377-82(May 1967). (In Italian).

Methods for testing structural materials are described. These include: creep tests on SAP tubes pressurized by a gas; and dynamic resistance tests of cylindrical and spherical vessels by means of an inner explosion simulating the blast due to an actual accident. (P.C.H.)

36850 STRUCTURAL CHANGES AND MECHANICAL PROPERTIES OF ANNEALED MOLYBDENUM. Drachinskii, A. S.; Kaverina, S. N.; Pisarenko, V. A.; Trefilov, V. I. (Inst. of Metal Physics, Kiev). Fiz. Metal. Metalloved., 23: 1108-12 (June 1967). (In Russian).

The formation microstructure and submicrostructure of technically pure Mo was influenced by the redistribution of impurities during annealing at 1200 to 1900°C. At the early stages of recrystallization it was possible to observe impoverished solid solutions formed by the segregation of diffused impurities at the boundary of substructure. Annealing in a 10^{-4} mm Hg vacuum at temperatures exceeding 1600°C resulted in a considerable decarbonization of the specimens. The mechanical properties of Mo after annealing were congruent with the structure of the metal and content of impurities in the solid state. (R.V.J.)

36851 TEMPERATURE DEPENDENCE OF THERMAL DIFFUSIVITY OF NIOBIUM AND TANTALUM. Akhmetzyanov, K. G.; Pozdnyak, N. Z.; Dobrovol'skii, A. F. (Moscow State Univ.). Teplofiz. Vys. Temp., 5: 179-81(Jan.-Feb. 1967). (In Russian).

The thermal diffusivity of sintered and twice zone-refined Ta and Nb was determined by the method of thermal waves at temperatures of 303 to 1173°K. Cylindrical specimens were 3 to 5 mm in diameter and 150 to 200 mm long. Ta specimens contained 0.5%

Nb and 0.079% other impurities; Nb specimens contained 0.5% Ta and 0.305% other impurities. The thermal diffusivity of Ta remains roughly constant in the whole temperature range tested, while the thermal diffusivity of Nb increases somewhat. (ATD)

36852 VAPOR PRESSURE OF MOLYBDENUM AS RELATED TO PURITY. Kovtun, G. P.; Kruglykh, A. A. Izv. Akad. Nauk SSSR, Metal., No. 2, 222-4(Mar.-Apr. 1967). (In Russian).

The volatility of molybdenum as a function of purity and the vapor pressure of this metal with various impurity concentrations were studied. Powdered metal specimens and specimens subjected to zone recrystallization were studied. The powdered metal contained the following basic impurities (in wt %): 0.008 Fe, 0.005 Ni, 0.003 Co, 0.002 Ti, 0.002 Cu, 0.008 O, 0.0002 H, 0.001 N, and 0.004 C. The purity of the zone-recrystallized metal was evaluated from the ratio of electrical resistance at 295°K to that at 4.2°K. The initial metal powder showed a ratio of 40 to 50, while the ratio for the refined metal was 15,000. Rates of vaporization and vapor pressure were determined and tabulated from 1970 to 2380°C. The spectral emissive power of Mo at a wavelength of 0.656 μ was measured at 0.42 to 0.43, which disagrees with the generally accepted value of 0.37. The experimental results were analyzed by the method of least squares to give the following expressions for vapor pressure: for zone recrystallized Mo—$\log_{10}P = 11.08 - (35{,}500/T)$; for powder metal—$\log_{10}P = 10.72 - (33{,}900/T)$. The heats of vaporization in the given temperature range were 162.2 ± 1 and 155 kcal/g/atom, respectively. The results for the vapor pressure of refined Mo are 30% higher than the most reliable data in the literature. A comparison of curves for the vapor pressure of Mo as a function of temperature showed that the vapor pressure of the powder metal is 1½ to 2 times as high as that of the refined metal. This is explained by the fact that the powdered metal behaves like an alloy with components having vapor pressures several orders of magnitude greater than that of Mo. This also explains the difference in the heats of vaporization. The metal is apparently nearly monocrystalline after zone recrystallization. (ATD)

36853 SELF-DIFFUSION OF NIOBIUM IN SOME OF ITS ALLOYS WITH TUNGSTEN. Lyubimov, V. D.; Gel'd, P. V.; Shveikin, G. P.; Sutina, Yu. A. Izv. Akad. Nauk SSSR, Metal., No. 2, 84-7(Mar.-Apr. 1967). (In Russian).

The diffusion characteristics of Nb in solid solutions with W were studied. Commercially pure metallic Nb and W were used for making the alloys. Macrocrystalline specimens containing 5, 10, and 30 wt % W were studied. The surface layer of the specimens was activated with ^{95}Nb and the diffusion mobility of Nb was determined by removing layers and measuring the integral activity of the remainder. Diffusion annealing was done at 1600 to 2000°C, the duration being selected to give a diffusion layer 200 to 500 μ thick. The resultant data are tabulated and graphed with an overall error of ±(12 to 17%). The high annealing temperatures, macrocrystalline structure of the specimens (grain size of 3 to 5 mm), and the linear relationship between the natural logarithm of the coefficient of self-diffusion and inverse temperature give a sound basis for assuming that the results pertain to parameters of volumetric diffusion. The part played by boundary self-diffusion was not significant under the given experimental conditions. It was found that self-diffusion of Nb in its alloys with W is a complex function of composition, increasing sharply up to about a 5% W concentration and then rapidly falling. It is pointed out that many other properties of Nb–W alloys show anomalous behavior at this same 5% W concentration, specifically electrical resistance, hardness and melting point. A theoretical explanation is given for this phenomenon in terms of the individual properties of the atoms and their spatial topography. (ATD)

36854 GENERATION OF MICROCRACKS IN Mo-35 AT PERCENT Re ALLOY. Demkin, Yu. I. (Inst. of Quality Steels, Moscow). Fiz. Metal. Metalloved., 23: 754-6(Apr. 1967). (In Russian).

Ingots of electron-beam melted Mo-base alloy containing 35 at.% Re, annealed in H_2 at 2000°C for 3 hr and at 1800°C for 3 hr, was forged into 6×6 mm^2 bars. The bar specimens with a notch 0.8 mm deep and 0.8 mm wide were subjected to impact test at −196°C. The work consumed for fracturing amounted to 0.3 kg/m. The fracture was coarse and crystalline with numerous microcracks not-connected with the main crack. All the microcracks generated in a twin interlayer. This indicates the importance of twinning in microcrack formation. Several mechanisms of microcrack generation were observed, but each one was found to be associated with mechanical twinning. Most of microcracks were formed at the point of intersection of twinned crystal interlayers. These findings show that the decisive stage in failure of Mo alloys with high Re content is the crack propagation. (tr-auth)

36855 LOW CYCLE FATIGUE CRACK PROPAGATION IN A201B, A302B, AND A517F PRESSURE VESSEL STEELS. Crooker, T. W.; Lange, E. A. (Naval Research Lab., Washington, D. C.). Weld. J. (N. Y.), 46: 322s-328s(July 1967).

Low cycle fatigue crack propagation studies were conducted on A201B, A302B, and A517F pressure vessel steels in ambient air and in two aqueous environments, simulated boiler water and 3.5% salt water. The studies employed plate bend fatigue specimens which had been machined from the shell materials of full-size pressure vessels. The vessels had previously undergone fatigue testing under the auspices of the Pressure Vessel Research Committee (PVRC). Empirical relationships were developed between the fatigue crack growth rate and total strain range. Using these relationships, comparisons were made among the fatigue crack propagation characteristics of the three steels in air and in aqueous environments. In addition, estimates of structural fatigue life based on these relationships were compared with the results of the PVRC full-size pressure vessel fatigue tests. (auth)

36856 AGEING CHARACTERISTICS OF Cu–Be–Al ALLOYS. Koiwa, Masahiro; Yamaguchi, Sadae; Hirabayashi, Makoto (Tohoku Univ., Sendai). Trans. Jap. Inst. Metals, 8: 62-9 (Jan. 1967).

The aging characteristics of the Cu–Be–Al ternary alloys, containing 9 ~ 11 at.% Be and 6 ~ 9 at.% Al, were studied by means of hardness and tensile tests, optical and transmission electron microscopy, x-ray and electron diffraction, and calorimetric measurements. The investigation was done mainly on the specimen containing 9.07 at.% Be and 9.05 at.% Al, which was initially quenched from 800°C, where the two phases (α and β) are in equilibrium, and then aged at 340°C for various periods. The changes in various properties during aging were due to the precipitation in the α phase and the decomposition of the β phase, both of which terminated in the equilibrium state, ($\alpha + \gamma$). The most hardened state attained by 1.5 hr aging was attributed to the formation of G.P. zones in the α phase and the decomposition of the β phase into the α and intermediate phases. The crystallographic orientation relations between the matrix and these phases in the course of the aging process were determined. Finally the age-hardening of the alloys was briefly discussed. (auth)

36857 THE VISCOSITIES OF LIQUID URANIUM, GOLD, AND LEAD. Ofte, D. (Mound Lab., Miamisburg, Ohio). J. Nucl. Mater., 22: 28-32(Apr. 1967). (MLM-1370J).

The viscosity of liquid uranium metal was measured by an absolute method in an oscillating cup viscosimeter. To verify the accuracy of the viscosimeter, the viscosities of liquid gold and lead metals were measured for comparison with reported values. The viscosity of the liquid 99.97% pure lead decreased linearly on a plot of log viscosity as a function of reciprocal absolute temperature from 2.47 centipoises at 337°C to 0.95 centipoise at 1114°C. The viscosity of molten 99.97+% pure gold decreased from 4.84 to 3.58 centipoises over a 1063 to 1364°C temperature interval. The viscosity of 99.9+% pure uranium was measured at five temperatures between 1141 and 1248°C. A least squares analysis of the data showed that the viscosity decreased from 6.5 to 5.4 ± 0.2 centipoises between 1133 and 1248°C with an activation energy for viscous flow (E_{vis}) of 7260 cal/g-atom. Liquid self-diffusion, calculated from the viscosity data, increased from 1.92×10^{-5} cm^2/sec to 2.51×10^{-5} cm^2/sec between 1133 and 1248°C. The experimental melting point viscosity and E_{vis} compared favorably with the 5.9 centipoises and 7540 cal/g-atom values predicted from theoretical considerations. The 6.5 centipoises for uranium at its melting temperature is the highest viscosity reported in the literature for a pure liquid metal. (auth)

36858 SELF AND IMPURITY DIFFUSION IN ALPHA-ZIRCONIUM. Naik, M. C.; Agarwala, R. P. (Bhabha Atomic Research Center, Bombay). Acta Met., 15: 1521-5(Sept. 1967).

Random-walk analysis and the Hart relation were used to analyze quantitatively the contribution of randomly oriented dislocations towards apparent volume diffusivity for self and impurity (Sn, Cr, Ag, V, and Mo) in α-Zr. Quantitative analysis indicated the enhancement of apparent volume diffusivity due to the presence of randomly distributed dislocations (even of the order of 10^6 to 10^7 dislocation lines/cm^2). (auth)

36859 ON THE ANOMALOUS DIFFUSION BEHAVIOR OF B.C.C. TRANSITION METALS. Gibbs, G. B. (Berkeley Nuclear Labs., Eng.). Acta Met., 15: 1551-2(Sept. 1967).

Further discussion is presented in disagreement with a literature claim for a single diffusion mechanism in β-zirconium and β-titanium with arguments for anomalous self-diffusion parameters. Most of the discussion centers around the possibility that diffusion in β-zirconium could be by monovacancies at low temperatures and by divacancies at higher temperatures. (P.C.S.)

Structure and Phase Studies

Refer also to abstracts 36834, 36850, and 38283.

36860 (BNL-11594) INTERATOMIC POTENTIALS FOR POINT DEFECT CALCULATIONS FOR NIOBIUM, MOLYBDENUM, TANTALUM, AND TUNGSTEN. Johnson, R. A. (Brookhaven National Lab., Upton, N. Y.). July 19, 1967. 11p. (CONF-670718-1). Dep. CFSTI.

From NATO Conference on High Temperature Materials, Sandefjord, Norway.

Interatomic potentials can be found for use in model calculations for defect properties of the refractory metals, Nb, Mo, Ta, and W, although it is difficult to obtain unique results. For each metal, several calculations for better-known defect properties would have to be carried out with a variety of potentials to determine which one gives the most realistic values. Then these potentials could be used for further calculations. The potentials are not as "smooth" as the α-Fe interaction used in earlier calculations. They show a tendency towards requiring a local maximum between first and second neighbor distances. This effect is more pronounced for Nb and Ta than in Mo and W. There is also a tendency for the well depth to be greater at the second neighbor distance than at the first. (auth)

36861 (CEA-R-3188) LA METALLOGRAPHIE EN CELLULE CHAUDE AU DEPARTEMENT DE METALLURGIE. (Hot-Cell Metallography in the Metallurgy Department). Le Boulbin, Emile; Vignesoult, Nicole (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1967. 22p. (In French). Dep.

Following six years experience, a stage was reached where all conventional metallographic processes are used regularly and relatively without difficulty considering the handicap of the biological protection. This was made possible by using strong, compact materials, which can easily be outgassed for decontamination. In a certain number of cases however, the normal methods are of no use without a certain number of precautions. This led to the development of other processes normally little used in metallography. Such a case is impregnation in vacuo making it possible to consolidate brittle or cracked elements, which would not normally withstand the cutting-up process. Similarly, β-γ autoradiography considerably widened the possible field of investigations. (auth)

36862 (FEI-44) TEORIYA GOMOGENNOGO ZAROZHDENIYA GAZOVYKH POR V METALLAKH. (Theory of the Homogeneous Inception of Gas Pores in Metals). Semenov, L. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1966. 14p. (In Russian). Dep.

If a metal is subjected to cyclotron bombardment by inert gas ions, a strongly supersaturated solution of inert gas in metal is obtained. At a sufficiently high temperature the supersaturated solution breaks down to form a large number of gaseous pore-complexes consisting of gas atoms and vacancies. An analogous situation takes place in fissionable materials. This process can be considered as a specific phase transition. In this case the gaseous pores play the role of nuclei of the new phase. The homogeneous growth of the new phase was investigated mathematically on breakdown of a supersaturated, inert gas, solid solution. An expression was obtained for the critical pore size, and the rate of formation of stable nuclei was also found for the quasistationary period of the conversion. (TTT)

36863 (MLM-1347) REACTOR FUELS AND MATERIALS DEVELOPMENT PLUTONIUM RESEARCH, APRIL-SEPTEMBER 1966. (Mound Lab., Miamisburg, Ohio). July 28, 1967. Contract AT(33-1)-Gen-53. 32p. Dep. CFSTI.

Phase equilibria in the ternary system in the range Pu-PuFe-PuMn were investigated. The principal characteristics of this system were found to be a complete series of solid solutions between the binary compounds, PuMn and $PuFe_2$, with a minimum solidus temperature located near PuMn, and a eutectic type valley extending across the diagram from the Pu-Mn binary eutectic at 520°C to the Pu-Fe eutectic at 413°C. The internal friction of all the allotropes of Pu was measured from 25 to 575°C by a torsion pendulum technique. The internal friction increased from 0.0007 to 0.2 over this temperature range. A considerable difference was noted in the internal friction of the β, γ, and δ phases depending on whether the sample was being heated or cooled. The heat capacities of all of the allotropes of Pu, including the liquid, were measured from 60 to 731°C with electrorefined metal. The first valid measurement for the δ phase, 8.50 cal/g-atom-°C, was reported. Measurements in the differential calorimeter indicated that the $\gamma \rightarrow \delta$ transformation consumed 169 cal/g-atom, but only 89 cal/g-atom were released during the subsequent $\delta \rightarrow \gamma$ transformation. Further cycling between the γ and δ phases had no effect on the heat of the $\gamma \rightarrow \delta$ transformation, but the heat of the $\delta \rightarrow \gamma$ transformation continuously decreased. The liquid densities of the Pu alloys containing 5.5, 10.8, and 22.4 at. % U, respectively, were measured from near their liquidus temperatures to 870°C. These experimentally determined density values were approximately 1% larger than the calculated values based on ideal solutions of Pu and U. The viscosities of liquid Pu alloys containing 5.5, 10.8, 16.6, and 22.4 at. % U were determined from their liquidus temperatures to over 800°C. The viscosity reached a maximum value of 10.1 centipoise at the liquidus temperature of 621°C for the alloy with 10.8 at. % U. This alloy is located near the minimum liquidus temperature in this binary system. (16 references) (auth)

36864 (NASA-TN-D-4094) DISLOCATION STRUCTURES IN SLIGHTLY STRAINED TUNGSTEN AND TUNGSTEN-RHENIUM AND TUNGSTEN-TANTALUM ALLOYS. Stephens, Joseph R. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Aug. 1967. 20p. CFSTI.

Deformation substructures of polycrystalline W, W-2, 9, and 24 wt % Re, and W-3 wt % Ta were studied by transmission electron microscopy. The stress-strain curve for unalloyed W showed gradual yielding followed by work hardening. Electron micrographs indicated a gradual increase in dislocation density with increase in strain up to 5.0%. Dislocations, although frequently jogged, are straight over moderate distances and are in a random array. Stress-strain curves for alloy specimens of tungsten-2 and 9% Re and W-3% Ta exhibited a drop in stress at yielding followed by only slight work hardening. Electron micrographs of these specimens revealed the absence of dislocations at strains of 0.05, 0.1, and 0.5%. After 2.0% strain, the three alloys exhibited dense dislocation networks. W-3% Ta is characterized by straight, frequently jogged dislocations comparable with the dislocation structure in unalloyed W after a similar amount of strain. In contrast, W-2% Re exhibited dislocations that contain widely spaced jogs, while W-9% Re developed a cell structure after the relatively small strain of 2.0%. The W-24% Re alloy contained a few dislocations after 0.1% strain, while after 0.5% strain, twins were evident. Dislocation slip bands apparently preceded the twins. The stress-strain curve for the alloy indicated that twinning commenced after approximately 0.25% strain. These results indicated that the primary effect of low Re concentrations (2 and 9%) in W is to increase dislocation multiplication after macroyielding by reducing the Peierls-Nabarro force (lattice resistance to dislocation motion). The dislocation bands that precede twins in W-24% Re may be caused by localized internal stresses resulting from a metastable structure, for example, clustering of Re atoms. (auth)

36865 GROWTH OF PLUTONIUM α GRAINS UNDER HYDROSTATIC PRESSURE. Cornet, J.; Spriet, B. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Mem. Sci. Rev. Met., 64: 467-76(May 1967). (In French).

A device capable of providing pressures of 100 kb at 1000°C for long periods of time is described. The apparatus was used for studying the grain growth of α Pu under hydrostatic pressure. The grains obtained had a maximum section of 10 mm^2. (tr-auth)

36866 EFFECT OF TITANIUM ON PHASE CONSTITUTION AND DUCTILITY OF CHROMIUM-NICKEL STEEL WITH HIGH CONTENT OF BORON. Grebennikov, R. V.; Chirkin, A. V.; Vukolova, V. N.; Shavrova, T. N.; Balanik, I. S. At. Energ. (USSR), 22: 384-9(May 1967). (In Russian).

By metallographic, x-ray, and electrochemical analyses, the phase composition of Cr-Ni steel, alloyed with Ti and containing 3 to 3.5% B and its hot ductility were investigated. The introduction of Ti led to the formation of TiB_2 and decreased the quantity and volume of the boride phase. With excess Ti there was formation of intermetallic-type x phase. By thermal processing the intermetallide can be dissolved, thereby decreasing the volume of brittle components in the alloy and increasing its ductility. Alloys with 3 to 3.5% B and 8 to 9% Ti after thermal processing, are rolled with reductions up to 40%. (tr-auth)

36867 EFFECT OF BORON AND CERIUM ON THE MODE OF DISTRIBUTION OF EXCESS CARBIDES AT GRAIN BOUNDARIES IN ZhS-TYPE COMPLEX NICKEL-BASE ALLOY. Gaiduk, V. V.; Natapov, B. S.; Ol'shanetskii, V. E. (Zaporozhe Machine-Building Inst., USSR). Fiz. Metal. Metalloved., 23: 685-9 (Apr. 1967). (In Russian).

The possibility of changing continuous layers of carbide phase surrounding the matrix of a complex heat-resistant Ni alloy into chains of globular carbides by introducing B and Ce during melting has been investigated. ZhS-type heat-resistant alloy (containing 19% Cr, 3.5% W, 2.5% Mo, 4.8% Co, 2.3% Al, 2.9% Ti and remainder Ni) was used as a basic alloy. Twenty-four alloy varia-

tions were obtained by adding B or Ce or both. The specimens were solution annealed at 1200°C for 4 hr and aged at 980°C for 100 hr. Microstructural analysis revealed that the specimen containing 0.002% Ce had a continuous network of stable form of carbides surrounding grains of the matrix. Increasing the Ce content to 0.05% led to the replacement of the continuous carbide network by separate, short, partially spheroidized layers. Chains of highly spheroidized carbide particles were observed when Ce content was increased to 0.10–0.20%. Analogous results were obtained when B was introduced into Ni-base alloy. The original structure was still preserved with 0.01% B content. When B content was increased to 0.04%, the continuous boundary network was replaced by highly spheroidized carbide particles. A further increase in B content (up to 0.2%) did not bring about any significant changes in the form of carbide particles. (auth)

36868 FUSIBILITY DIAGRAM OF THE Ti–Zr–Cr SYSTEM. Kornilov, I. I.; Belousov, O. K.; Musaev, R. S. Izv. Akad. Nauk SSSR, Metal., No. 2, 201-3(Mar.-Apr. 1967). (In Russian).

The fusibility diagram of alloys in the ternary system Ti–Zr–Cr in the region bounded by the binary system Ti–Zr and the section passing through the compounds $TiCr_2$ and $ZrCr_2$ was studied. The available data on the binary diagrams which make up the given ternary system are briefly reviewed. About 70 alloys in all were studied. The specimens were melted in an arc furnace with permanent W electrode in a He atmosphere. Ingots weighing 15 grams were produced and remelted three times. Current was passed directly through specimens measuring 20 × 6 × 3 mm in a vacuum furnace and the melting points were measured with an optical pyrometer. The experimental results were used for plotting isotherms of the solidus curve showing the nature of the variation in the initial melting point for alloys in the given region of the ternary system. The isotherms for the initial melting points of alloys in the Ti–Zr–Cr system form a surface with maximum melting point at the Ti and Zr vertices with a gradual reduction in the melting point toward the central section of the concentration triangle. The results indicate the existence of a broad region of solid solutions at high temperatures in this system based on β–Ti, β–Zr, and Cr. (ATD)

36869 SOLID SOLUTIONS OF THE Zr–Nb–Hf SYSTEM. Fedorov, T. F.; Popova, N. M.; Skolozdra, R. V. Izv. Akad. Nauk SSSR, Metal., No. 2, 204-5(Mar.-Apr. 1967). (In Russian).

To determine the lattice parameters and regions of homogeneous solid solutions, 17 Zr–Nb–Hf alloys were melted, annealed at 1700°C for 100 hr or 1000°C for 1000 hr, and quenched. Since Zr and Nb, Hf and Nb, and Hf and Zr form a continuous series of solutions, it was expected that a continuous ternary solid solution with a bcc lattice would exist in the Zr–Nb–Hf system at temperatures above 1700°C (the temperature of Hf polymorphic transformation) and limited solid solutions with bcc and hexagonal lattices below 1700°C. However, only the alloys with more than 60 at.% Nb proved to be single-phase with a bcc lattice. The alloys with 20 to 60 at.% Nb also contained some hexagonal phase and alloy with less than 20 at.% Nb contained only the hexagonal phase. This indicates that solid solutions with low Nb content are decomposed on cooling. At 1000°C, a two-phase region Nb(Zr, Hf) + α – Hf(Nb, Zr) was formed. The hypothetical equilibrium diagram of Zr–Nb–Hf system at 1000°C is shown. (ATD)

36870 DISLOCATION DENSITIES IN TUNGSTEN. Warlimont-Meier, Barbara; Beardmore, P.; Hull, D. (Univ. of Liverpool). Acta Met., 15: 1399-1402(Aug. 1967).

The densities were measured by etch pitting and electron microscopy. Results show that the dislocation multiplication rate determined by the two methods and the density as a function of strain at 295°K depends on the technique used. It is concluded that the use of etch pit techniques to determine the dislocation density is more likely to produce significant errors in determining absolute values of dislocation properties than is the use of electron microscopy. (J.R.D.)

36871 PHASE DIAGRAMS OF THE GADOLINIUM–RHENIUM AND ERBIUM–RHENIUM SYSTEMS. Savitskii, E. M.; Khamidov, O. Kh. (Inst. of Metallurgy, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 649-55(Apr. 1967). (In Russian).

A study was made of 16 alloys of the Gd–Re system and 15 alloys of the Er–Re system. The alloys were melted from 99.98%-pure Re and 99.5%-pure Gd, and Er and phase diagrams of the systems were plotted. The phase diagram of the Er–Re system was similar to that of the Gd system. The existence of $GdRe_2$ compound, which was formed at 2430 ± 50°C, was established in the Gd–Re system and that of $ErRe_2$ compound, which was formed at 2500 ± 50°C, was established in the Er–Re system. The solubility of Re in Gd was insignificant; that of Gd in Re was 0.3 to 0.4 at.%. The solubility of Re in Er was less than 1.0 at.%; that of Er in Re was less than 0.35 at.%. (ATD)

36872 PHASE DIAGRAM OF THE TITANIUM–TANTALUM SYSTEM. Budberg, P. B.; Shakhova, K. N. (Inst. of Metallurgy, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 656-60(Apr. 1967). (In Russian).

Specimens of Ti–Ta alloys containing 10 to 99% Ti were levitation arc-melted-forged at 850 to 1150°C, depending on Ta content, and homogenized at 1200°C for 24 hr. Some specimens were vacuum annealed at 1000 and 800°C for 25 and 50 hr, respectively, and water quenched; other specimens were annealed at 600°C and furnace cooled. A phase diagram of the Ti–Ta system, was plotted on the basis of the microscopic and x-ray diffraction pattern examination. At 600°C the solubility of Ta in Ti was 11 wt %. The hardness of the alloys quenched from 1000°C sharply increased with increasing Ta content, reached a maximum of about 230 kg/mm^2 at a Ta content of 30%, and gradually decreased to 105 kg/mm^2 (the hardness of pure Ta) with further increase in Ta content. The hardness of alloys annealed at 600°C gradually increased with increasing Ta content and reached a maximum at a Ta content of 40%. Alloys containing 10% Ta had the highest modulus of elasticity. All alloys had an almost same Poisson ratio of 0.3 to 0.4. The two-phase $\alpha + \beta$ region at 600°C extended from 11 to 75 wt % Ta. (ATD)

36873 INVESTIGATION OF THE PHASE DIAGRAM OF THE TERNARY MOLYBDENUM–ZIRCONIUM–TITANIUM SYSTEM. Zakharov, A. M.; Savitskii, E. M. (Inst. of Metallurgy, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 661-7(Apr. 1967). (In Russian).

Ingots of Mo–Zr–Ti alloy, arc melted from 99.95% pure sintered Mo, 99.7% pure iodide Zr, and 99.9% pure Ti, were investigated in the as-cast condition and also after upsetting with a 60 to 80% reduction and subsequent annealing in a vacuum of 5×10^{-6} mm Hg at 1500 and 1000°C for 150 and 400 hr, respectively. The investigated ternary alloys included alloys containing Mo and Zr at the 2.1 : 1 and 3 : 1 ratio, and alloys with a constant Ti content of 10 or 30%. On the basis of the obtained data, a projection of the ternary Mo–Zr–Ti system on the plane of the concentration triangle, and isothermic sections at 1500 and 1000°C were plotted. In the investigated temperature range, the structure of the ternary Mo–Zr–Ti system was found to be analogous to that of the Nb–W–Zr and Nb–Mo–Zr systems. The alloys had a single- or two-phase structure. Single-phase alloys were ternary β-solid solutions which, depending on the alloy composition, were rich in Ti, Mo, or Zr. The structure of two-phase alloys, in addition to the crystals of the ternary β-solid solution, contained also crystals of Mo_2Zr chemical compound. The combined solubility of Mo and Zr in β–Ti in the solid state decreased with decreasing temperature. For example, in alloys containing Mo and Zr in a 3 to 1 ratio, the solubility of Mo and Zr in β–Ti was higher than 90% at 1500°C, and about 82 to 83% at 1000°C. Additions of Ti in an amount of up to 30% to binary Mo–Zr alloys increased the limited solubility of the components in the solid state to the complete solubility. (ATD)

36874 PHASE DIAGRAM AND PROPERTIES OF HAFNIUM–SCANDIUM ALLOYS. Naumkin, O. P.; Terekhova, V. F.; Savitskii, E. M. (Inst. of Metallurgy, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 711-13(Apr. 1967). (In Russian).

Twelve Hf–Sc alloys were thrice remelted from 99.5%-pure distilled Sc and 98.73%-pure iodide Hf in He atmosphere, vacuum annealed, and investigated by various methods of physicochemical analysis. On the basis of obtained results, a phase diagram of the Sc–Hf system was plotted. It was found that Hf with Sc forms a continuous series of solid solutions in α and β-modification. The atom size and structure of Sc is close to Ti, Zr, and Hf. All these metals have a close-packed hexagonal lattice α-modification, and a body-centered cubic structure β-modification with lattice parameters 1.641 Å for Sc and 1.59 Å for Hf. The maximum resistivity of 155 to 162 μ/ohm/cm obtained in alloy containing 50 to 55% Sc. (ATD)

36875 USE OF SIMPLEX LATTICE METHOD FOR CONSTRUCTION OF COMPOSITION–PROPERTY DIAGRAMS. Novik, F. S.; Mints, R. S.; Malkov, Yu. S. (All-Union Correspondence Polytechnic Inst., Moscow. Inst. of Metallurgy, Moscow). Zavod. Lab., 33: 840-7(1967). (In Russian).

Descriptions are given of simplex lattices, which enable construction of component–property diagrams for systems with arbitrary number of components. A diagram of the Ni–Ni_3Nb–Ni_3Al system liquidus was constructed. The liquidus point for the system consisting of 10% NiNb, 60% NiAl, and 30% Ni was found at 1420°C. (R.V.J.)

36876 PHASE STABILITY IN METALS AND ALLOYS. Battelle Institute Materials Science Colloquia, Geneva and Villars, Switzerland, March 7–12, 1966. Rudman, Peter S.; Stringer, John; Jaffee, Robert I. (eds.). McGraw-Hill Series in Materials Science and Engineering. New York, McGraw-Hill Book Co., 1967. 607p. $21.50. (CONF-660340).

Twenty-eight papers from the Colloquium review the problem of why a given structure or phase occurs in metals and alloys under given conditions from both experimental and theoretical approaches Phase stability is considered in particular classes of materials including: pure metals and substitutional solutions; intermetallic phases; interstitial phases and solutions; and liquids and defect solids. (P.C.S.)

Radiation Effects

Refer also to abstracts 36307 and 38741.

36877 (BNWL-SA-1112) PREPARATION OF IRRADIATED HIGH-TEMPERATURE SERVICE NICKEL BASE ALLOYS FOR METALLOGRAPHY. Gruber, W. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [nd]. Contract AT(45-1)-1830. 9p. (CONF-670533-3). Dep. CFSTI.

From 21st AEC Metallographic Group Meeting, Upton, N. Y.

Irradiated tensile samples fabricated from several Ni-base alloys were examined metallographically after testing to study microstructural relations to physical properties, testing criteria, irradiation induced phenomena, and heat treatment histories. Specimens were examined optically and replicas were made for electron microscopy. Preparation, etching, and replicating techniques are described; differences between irradiated and non-irradiated materials are discussed; and illustrations of results are presented. (auth)

36878 (EURAEC-1864) INFLUENCE OF NITROGEN IN IRON AND STEEL UNDER FAST NEUTRON IRRADIATION. Quarterly Report No. 6, January 1–March 31, 1967. (Societa Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). May 1967. Contract 074-65-10-TEEI(RD). 15p. (EUR-3368). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Measurements were made of the tensile properties of irradiated Ferrovac E at different temperatures and strain rates; the range of strain rates is 1.5×10^{-5} to 2×10^{-1} sec^{-1}. Transition temperature measurements were made on Si- and Al-killed ASTM A212 base steels after irradiation and of iron and steel specimens annealed after irradiation (isochronal annealing). Magnetic viscosity studies were made on Fe–Si 6.5% alloys. Damage dosimetry studies were carried out with measurement of the radioinduced modifications in Ultraperm magnetic properties. These results should be compared with the tensile properties of irradiated Ferrovac E. (auth)

36879 (EURAEC-1881) RESEARCH TO DETERMINE THE LONG-TERM MECHANICAL PROPERTIES OF METALS SUBJECTED TO MECHANICAL STRESS AT ELEVATED TEMPERATURES AND NEUTRON IRRADIATION. Seventeenth Quarterly Report, January 1–March 31, 1967. Siegfried, W. (Battelle Memorial Inst., Geneva (Switzerland)). June 1967. Contracts 100-62-12-RDS; 057-64-7-TEES(RD). 39p. (EUR-3377). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Theoretical studies were made along with investigations concerning possible errors that may occur as a result of simplifications based on the calculations. Appropriate procedures for the application of the method of evaluation developed were elaborated. The relation between the shape of the time-to-rupture curve and the volume of activation, secondary creep rate, and number of fissure germs was determined. Time-to-rupture tests on a Cr–Mo–V–cast steel with abnormal behavior were evaluated along with those on stainless alloy 304 with and without neutron irradiation. (auth)

36880 (JUL-464-RW) EIN VERSUCH ZUR BESTIMMUNG DER VERLAGERUNGSFUNKTION nu(T) IN GOLD. (A Method for Determination of the Damage Function nu(T) in Gold). Schilling, W.; Voelkl, J. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Mar. 1967. 39p. (In German). Dep.

An experiment to determine the so-called radiation damage function in Au is described. The damage function, ν (T), is defined as the number of stable Frenkel defects produced at low temperatures by a primary atom to whom the energy T is transferred by irradiation with fast particles. A stack of identical Au foils was irradiated with high energy protons and α particles. Traversing the foils the particles are slowed down and therefore each foil was irradiated with a different mean particle energy. Measurement of the electrical resistance change of each foil gave the total number of defects from which the damage function could be calculated. Large experimental and theoretical difficulties appeared. One of the main experimental difficulties was the non-uniformity of the foil thickness. Furthermore, large corrections for increased defect production by particles scattered by large angles had to be made. (auth)

36881 (ORNL-4142) A STUDY OF RADIATION DAMAGE AND SUBSTITUTIONAL CHEMICAL IMPURITY EFFECTS IN SINGLE-CRYSTAL GERMANIUM SUBJECTED TO 40-keV. B^+, P^+, Al^+, As^+, AND Sb^+ IONIC BOMBARDMENT. Alton, G. D. (Oak Ridge National Lab., Tenn.). Aug. 1967. Contract W-7405-eng-26. 100p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee [Knoxville].

The time-temperature annealing of damage centers produced in germanium by substitutional impurity ions and the properties of p-n junctions after damage annealing were investigated. Physical effects occurring during energetic bombardment of surfaces, some properties of semiconductors, and radiation damage in semiconducting materials are discussed. The ion-implantation apparatus, sample preparation, the vacuum sealing assembly, the annealing apparatus, and resistivity measuring equipment are described. Thermoelectric probe measurements on n-type Ge prior to annealing supported the findings of others that regardless of the chemical identity of the energetic ion, acceptor states result. Subsequent annealing suggested that the damage centers begin to anneal away at about 200°C and that annealing is complete at about 550°C. The density of damage centers produced as a result of bombardment increased with ion mass and/or size. Resistivity changes as a result of bombardment up to 2×10^{15} ions/cm^2 were insignificant regardless of the mass and size of the particle. Data seemed to indicate that the resistivity changes observed are due to chemical impurities moving into substitutional positions rather than defect annealing. (M.C.G.)

36882 (RCN-77) DISLOCATION LOOPS IN NEUTRON IRRADIATED MOLYBDENUM. Elen, J. D. (Reactor Centrum Nederland, Petten). June 1967. 27p. Dep.

The technique of transmission electron microscopy was used to study the nature of dislocation loops in neutron-irradiated Mo. Consistent results were obtained for a sample of 89 loops of diameter ranging from 90 to 700 Å with an average of 190 Å. They were found to be prismatic loops of $\frac{1}{2}$ a ⟨111⟩ Burgers vector, chiefly interstitial in nature. For determination of the inclination of the loops towards the electron beam (here [001]), a mixed technique was used of rotation around a ⟨200⟩ g vector, followed by observation of the larger loops; and of observation of the contrast under operation of the [031] g vector, giving a clear difference in contrast intensity. (auth)

36883 THE EFFECT OF LOW-CYCLE FATIGUE AND NEUTRON IRRADIATION ON THE MECHANICAL PROPERTIES OF LOW-ALLOYED STEELS. Salkin, R. V. (Centre National de Recherches Metallurgiques, Liege). Trans. Amer. Nucl. Soc., 10: 113(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36884 THE IN-REACTOR CREEP OF COLD-WORKED ZIRCALOY-2 AND ZIRCONIUM-2.5 PERCENT NIOBIUM. Ross-Ross, P. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Trans. Amer. Nucl. Soc., 10: 114(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36885 EFFECTS OF IRRADIATION ON PROPERTIES OF COBALT. Angerman, C. L. (E. I. duPont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc., 10: 114-15(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36886 FAST-NEUTRON SPECTRA AND RADIATION DAMAGE RATES IN EBR-II. Rossin, A. D. (Argonne National Lab., Ill.); Kirn, F. S.; Armani, R. J.; Smith, D. M. Trans. Amer. Nucl. Soc., 10: 129(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36887 HIGH-TEMPERATURE TENSILE BEHAVIOR OF HELIUM-INJECTED TYPE-304 STAINLESS STEEL. Brager, H. (Atomics International, Canoga Park, Calif.); Kramer, D.; Rhodes, C. G.; Pard, A. G. Trans. Amer. Nucl. Soc., 10: 129-30(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36888 EFFECT OF CYCLOTRON-INJECTED HELIUM ON THE MECHANICAL PROPERTIES OF STAINLESS STEEL. Weir, J. R.; King, R. T. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 130-1(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36889 IN-REACTOR AND POSTIRRADIATION CREEP-RUPTURE PROPERTIES OF TYPE 304 STAINLESS STEEL. Bloom, E. E.; Weir, J. R. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 131-2(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36890 CORRELATION OF TENSILE AND FATIGUE PROPERTIES OF IRRADIATED 347 STAINLESS STEEL AT ROOM TEMPERATURE. Kangilaski, M.; Shober, F. R. (Battelle Memorial Inst., Columbus, Ohio). Trans. Amer. Nucl. Soc., 10: 132(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36891 IN-PILE EXPERIENCE WITH STAINLESS-STEEL-CLAD UO_2 FUEL ELEMENTS IN A BORATED PWR ENVIRONMENT. McClintock, D. R. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 10: 133(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36892 HIGH-TEMPERATURE RADIATION EMBRITTLEMENT OF HASTELLOY-X, INCONEL-625, AND AISI 347. Dixon, C. E.; Funk, C. W.; Weleff, W. (Aerojet-General Corp., Sacramento, Calif.). Trans. Amer. Nucl. Soc., 10: 133-4(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36893 BURST AND TENSILE PROPERTIES OF IRRADIATED INCOLOY-800 AND INCONEL-625 TUBING MATERIALS. Ogawa, S. Y. (General Electric Co., San Jose, Calif.); Spalaris, C. N. Trans. Amer. Nucl. Soc., 10: 134-5(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36894 NATURE OF RADIATION DAMAGE IN MATERIALS. Weir, J. R.; Bloom, E. E. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 161(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36895 STUDY OF THE EFFECT OF PROTON BOMBARDMENT ON THE OPTICAL CONSTANTS OF THIN METALLIC FILMS. Chechetenko, V. V.; Savchenko, E. V.; Fogel, Ya. M.; Shklyarevskii, I. N.; Yarovaya, R. G. Opt. Spectrosc. (USSR) (Engl. Transl.), 22: 341-3(Apr. 1967).

Translated from Opt. Spektrosk., 22: 626-30(Apr. 1967).

Investigations were carried out on the effect of proton beam bombardment with current densities of 1–5 $\mu A/cm^2$ and energy of 10 to 40 keV on the optical properties of thin Al and Ag films in the visible spectral region. No change in the optical properties of the Al films was detected. In Ag specimens with a low initial defect concentration (low values of the refractive index) a change in the refractive index of several tenths of a percent was observed after irradiation. (auth)

36896 INFLUENCE OF COMPOSITION AND NEUTRON IRRADIATION ON THE BRITTLENESS OF IRON AND STEEL. Rossi, F. S.; Castagna, M. (CNEN, Saluggia, Italy). Met. Ital., 59: 387-93(May 1967). (In Italian).

The effects of N on the intrinsic and radioinduced brittleness of Fe and steel were studied. Brittleness was measured as a change in the transition temperature of the fracture on sub-size V-notched Charpy specimens. The measurements, performed on different materials after irradiation and after further annealing of the irradiated materials, showed that N is a first order cause of embrittlement in irradiated Fe. However, by comparing impact tests with tensile tests of the same materials, the kind of deoxidizer added to iron seems to also play some important role in affecting the results. Post irradiation annealing appeared to be useful in differentiating the radiation sensitivity of the materials tested. (auth)

36897 INFLUENCE OF COMPOSITION AND OF NEUTRON IRRADIATION ON THE MECHANICAL PROPERTIES OF IRON OF DIFFERENT GRAIN SIZE. Castagna, M.; Ferro, A.; Rossi, F. S. (CNEN, Saluggia, Italy). Met. Ital., 59: 340-6(May 1967). (In Italian).

Some general observations made through research on the mechanical properties of irradiated plain carbon steel as a function of the specimens grain size are presented. The study was developed by checking the values of the parameters of the Petch equation $\sigma_y = \sigma_0 + k_y d^{-\frac{1}{2}}$ and their radioinduced changes. After irradiation the value of σ_0 appeared to be of the same order in iron containing free interstitials or when nitrogen and carbon were completely precipitated. Some interesting differences were observed in the yield point versus grain size relationship where the k_y value did not change in the interstitial free iron either before or after irradiation, while in the presence of free interstitials k_y passed to lower values after irradiation. At the largest fluences some anomalous behavior in the Petch relationship was observed in the coarse grain specimens of interstitial free iron: the anomalies disappeared after annealing at 200°C while at 130°C only some increase in the yield point and in the hardness values was observed. Some general conclusions are quoted as a consequence of the reported results. (auth)

36898 GAMMA RADIATION EFFECTS ON THE SPECTRUM OF ALUMINUM MECHANICAL RELAXATION AT TEMPERATURE RANGE FROM 150 TO 300°K. Naskidashvili, I. A.; Melik-Shakhnazarov, V. A.; Bydlinskaya, I. N. (Inst. of Physics, Tbilisi, USSR). Fiz. Metal. Metalloved., 23: 735-6(Apr. 1967). (In Russian).

Studies with pure 99.996% Al using automatic recorder of mechanical relaxation spectra showed that relaxation maximums were found at 200 to 300°K following plastic deformation of 0.05%. Annealing at 200°C increased the maximum of internal friction. The specimen was irradiated in the In–Ga IRT-2000 reactor. The spectrum of the specimen following γ-quantum irradiation and 9-day aging of 20°C resulted in a complete inhibition of maximums by irradiation and restoration of relaxation by aging. The experiments with irradiation of cold hardened and 0.05% deformed specimens, aged at room temperature, resulted in increased maximums. It was concluded that irradiation reduced maximums of internal frictions in annealed Al specimens and increased in cold hardened specimens. (R.V.J.)

36899 LOW FREQUENCY INTERNAL FRICTION IN ELECTRON IRRADIATED COPPER. Keefer, D.; Vitt, R. (Atomics International, Canoga Park, Calif.). Acta Met., 15: 1501-11 (Sept. 1967).

Low-frequency internal-friction measurements were made on electron-irradiated Cu. A well-defined peak at 240°K and a small peak at about 140°K were observed. The height of the 240°K peak increased and then decreased with increasing defect concentration. The 240°K peak is attributed to interstitials in association with dislocations. The arrival of vacancies at dislocations during annealing above 280°K suppresses the peak. Although the mechanism for the 140°K peak was not established, vacancies are thought to play a role. Only qualitative agreement was found between present results and those in cold-work studies. (auth)

Ceramics and Cermets

Corrosion and Erosion

Refer to abstract 36794.

Preparation and Fabrication

Refer also to abstracts 36799, 36942, and 36943.

36900 (AERE-R-2876) FABRICATION OF STAINLESS STEEL CANNED ANNULAR URANIUM-DIOXIDE FUEL ELEMENTS. Williams, N. R.; Lloyd, H.; Purchas, G.; Thorpe, T. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1959. 31p. Dep.

The manufacture of 12-in.-long fuel elements comprising annular discs of enriched UO_2 fuel canned in stainless steel for the gas-cooled Calder Hall channel in BEPO is described. The discs 1.5 in. OD × 1 in. ID × 0.5 in. thick were produced by warm pressing UO_2 at 750°C under 9 ton/in.^{2} (auth)

36901 (AI-CE-48) HEAVY WATER ORGANIC COOLED REACTOR. SURFACE FINISH IMPROVEMENT IN CAST UC SLUGS. Strausberg, S.; Katz, N. H.; Wolfe, H. J. (Atomics International, Canoga Park, Calif. Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Aug. 15, 1967. Contract AT(38-1)-430. 75p. Dep. CFSTI.

Preliminary studies were conducted to develop an economical process for preparing UC fuel slugs as specified for HWOCR requirements. The principal deterrents to the use of as-cast slugs were: surface defects, including "cold shuts" and exterior protuberances, and excess "bow" (nonstraightness). Techniques were investigated for improving the surfaces of as-cast slugs, either through modifications in the melting and casting operation or through machine-finishing operations. Melting and casting studies showed that UC slug surfaces are improved by: using outgassed molds (~2300°C), casting into preheated molds (~1000°C), casting with the melt at slight superheat, and casting with a reduced header (riser) thickness, which reduces slug bowing. Centerless grinding techniques were adapted to provide economical surface finishing of cast UC slugs with: dimensions and OD roundness

controlled to ±0.0005 in., total indicator reading (TIR) straightness controlled to 0.001 in., and surface finishes of <200 μin. (auth)

36902 (KAPL–3321) LWB/LSBR DEVELOPMENT PROGRAM: DEVELOPMENT OF MANDRIL OXIDE FUEL ELEMENTS. Lang, J. E.; Wisnyi, L. G.; Ploetz, G. L. (Knolls Atomic Power Lab., Schenectady, N. Y.). Mar. 1966. Contract W-31-109-eng-52. 16p. Dep. CFSTI.

CaO-stabilized cubic-phase ZrO_2 was investigated as a refractory mandril centrally located in the void in rod-type fuel elements. Specific geometric ZrO_2 shapes, such as rods, fibers, and spheres, may possibly be useful under specific, well-defined reactor operating conditions amenable to each shape. Hollow ZrO_2 spheres (bubbles) should be the most useful ZrO_2 shape under the widest range of reactor operating conditions, permitting the fuel to swell inward with little resistance, while tending to prevent mechanical relocation of the ceramic fuel into the central void. A possible drawback to the use of a ZrO_2 mandril in a UO_2–ZrO_2 fuel element is the likelihood of U diffusion into the ZrO_2 mandril at high temperature. This should not be a problem unless the steady-state central temperature in the fuel element is ≥~1700°C (3092°F). Under these conditions, a reaction barrier coating may be needed to prevent diffusion, or a material other than ZrO_2 could be used for the mandril. (auth)

36903 (LA–3707) FABRICATION OF CERAMIC COMPONENTS FOR USE IN PLUTONIUM ELECTROREFINING. Stoddard, S. D.; Nuckolls, D. E. (Los Alamos Scientific Lab., N. Mex.). Mar. 1, 1967. Contract W-7405-eng-36. 9p. Dep. CFSTI.

A method of fabricating ceramic cells and associated components for use in the electrolytic refining or electrowinning of Pu metal is described. Details for making such ware of impervious Al_2O_3 and MgO are described. References on the development of processes for the electrochemical preparation of up to 3.5 kg per batch of Pu and the ceramics required for such processes are also given. (auth)

36904 (NIJS-R–501) INFLUENCE OF ATMOSPHERE ON SINTERING HIGH SURFACE AREA URANIUM DIOXIDE. Kolar, D.; Brcic, B. S.; Zatler, B.; Marinkovic, V. (Nuklearni Institut Jozef Stefan, Ljubljana (Yugoslavia)). Apr. 1967. 13p. Dep.

The influence of reducing and oxidizing atmosphere on sintering UO_2 powders with different specific surface areas was investigated. Atmospheric influence depended on the activity of UO_2 powder. Combined effects of excess O in nonstoichiometric UO_2 and high surface area of initial powder may limit sintered density and lead to the formation of intergranular type of porosity. In such cases, higher densities may be achieved by sintering at lower temperatures or by sintering in H_2. Different observations reported by various investigators on the atmospheric influence on sintering UO_2 may result from different starting materials. (auth)

36905 (NP–16716) ANALISIS DE LOS DIFERENTES SISTEMAS DE PREPARACION DEL GRAFITO DENOMINADO DE PUREZA NUCLEAR. (Analysis of Different Modes of Preparation of High Purity Nuclear Graphite). Zepeda Gorostiza, Joaquin (Universidad Nacional Autonoma de Mexico, Mexico City. Escuela Nacional de Ciencias Quimicas). 1964. 170p. (In Spanish). Dep.

Thesis.

Basic principles in the operation of nuclear reactors are outlined and the constituent parts are briefly described. The classification of reactors is considered. Chemical and physical properties of graphite are reviewed and the use of graphite as moderator and reflector in reactors discussed. Other reactor uses for graphite are indicated. Methods for the production of artificial graphite and for the purification of natural graphite are given. The operations common to both systems of preparation (calcination, preparation of mixtures and formation of pieces, cooking and reduction of porosity) were studied comparatively. (J.S.R.)

36906 (ORNL–4000) PREPARATION OF LANTHANIDE OXIDE MICROSPHERES BY SOL–GEL METHODS. Hardy, C. J.; Buxton, S. R.; Lloyd, M. H. (Oak Ridge National Lab., Tenn.). Aug. 1967. Contract W-7405-eng-26. 68p. Dep. CFSTI.

Lanthanide oxide microspheres have been produced with a controlled size in the diameter range 50 to 500 μ, a density of up to 98% of the theoretical crystal density, a low surface area (0.01 to 0.1 m^2/g), and a high resistance to crushing (up to 3 kg for 500-μ-dia spheres). Hydroxide sols and gels were used as intermediates, and the resulting spheres were calcined at a relatively low final temperature (1000 to 1500°C), which depended on the crystal form required. Sols were prepared by precipitating the lanthanide hydroxides from lanthanide nitrate solutions with ammonium hydroxide, washing the precipitates thoroughly, and heating them for 1 hr at 80°C. These sols were concentrated by evaporation until they were 2 to 3 M in the metal ion and contained 0.06 to 0.25 mole of residual nitrate per mole of metal ion; then they were formed into gel microspheres of controlled size by partial dehydration with a long-chain alcohol in a tapered column. The gel spheres were dried further in vacuum at 120°C, heated to 500°C in vacuum to decompose the residual nitrate, and finally calcined to oxide microspheres at 1000 to 1500°C in air. Spectroscopic methods were used to rapidly determine the nitrate and metal ion concentrations in the sols, to study the form of bonding of the components (e.g., nitrate) of the sols and gels, and to estimate the sizes of the aggregates of colloidal particles. Electron microscopy and electron diffraction measurements showed that the initial precipitates of lanthanide hydroxides consisted of amorphous particles of 30 to 60 A in dia. When aged in the mother liquor, these particles changed into crystalline sheets up to several hundred Å in width; when thoroughly washed and aged in water, they changed into rods, tubes, or rolled sheets up to several thousand Å in length. Electron micrographs of replicas of etched polished surfaces of the dense oxides obtained by heating the gels to 1450°C showed 5- to 10-μ-wide grains that contained oriented crystalline units that were 0.2 to 0.5 μ wide. (P.C.H.)

36907 PREPARATION OF THORIUM–URANIUM OXIDE SOLS BY AMINE DENITRATION. Moore, J. G. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 94 (June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36908 DESIGN AND PERFORMANCE OF CONTINUOUS PROCESS EQUIPMENT FOR PREPARATION OF URANIA SOL. Irvine, A. R.; Chandler, J. M.; Haas, P. A.; McCorkle, K. H. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 94 (June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36909 PYROLYTIC-CARBON COATINGS FORMED AT HIGH DEPOSITION RATES. Scott, J. L.; Beatty, R. L. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 96 (June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36910 LANTHANUM AND YTTRIUM TUNGSTEN BRONZES. Broyde, Barret (Western Electric Engineering Research Center, Princeton, N. J.). Inorg. Chem., 6: 1588-9(Aug. 1967).

Preparation and properties of two W bronzes with La and Y are discussed. These materials have a cubic perovskite-type structure, are acid resistant, and are electrically conductive. Sc did not form a W bronze under the same conditions. (P.C.S.)

36911 THE PREPARATION AND ELECTRICAL PROPERTIES OF NIOBIUM SELENIDE AND TUNGSTEN SELENIDE. Kershaw, R.; Vlasse, M.; Wold, A. (Brown Univ., Providence). Inorg. Chem., 6: 1599-1602(Aug. 1967).

Large, homogeneous, well-formed crystals of $NbSe_2$ and WSe_2 were grown by a modification of Brixner's chemical-transport procedure. Electric conductivity of both specimens was measured on single-crystal specimens and results are compared with other investigators. $NbSe_2$ showed a metallic-like behavior, whereas WSe_2 behaved like a semiconductor with a relatively low electric conductivity. The superconducting transition for $NbSe_2$ on single crystals took place at 7°K, which agree with literature values for polycrystalline samples. (P.C.S.)

36912 NEW PREPARATION TECHNIQUE OF UO_2 THIN FOILS FOR THE OBSERVATION AT THE ELECTRON MICROSCOPE. Be, C. A.; Pedrazzini, G. (CISE, Milan). Met. Ital., 59: 320-2(May 1967). (In Italian).

A new method for preparing thin foils of sintered UO_2 and UO_2 and ThO_2 mixtures is described. The method also proved to be efficient for thermally treated sintered UO_2. The results obtained and the observations are subsequently described. (auth)

Properties Evaluations

Refer also to abstracts 36396, 36824, 36826, 36827, and 37240.

36913 (67-C-243-) STRENGTH OF NONSTOICHIOMETRIC OXIDES. Nadeau, J. S. (General Electric Co., Schenectady, N. Y. Research and Development Center). June 1967. 13p.

The reduction of high-temperature strength by nonstoichiometry was previously studied by a number of investigators. These studies indicated that the softening is probably related to the enhancement of diffusion. However, the nature of the high-temperature deformation process is not understood. The available infor-

mation on defect structures, diffusion, and high-temperature strength of nonstoichiometric FeO, TiO_2, and UO_2 are reviewed and compared with a variety of theoretical models to determine whether softening by nonstoichiometry has a common physical origin. It was concluded that none of the data are as yet sufficiently complete to permit a clear understanding of the phenomenon. (auth)

36914 (GEAP-5100-7) HIGH PERFORMANCE UO_2 PROGRAM. ALPHA AND BETA-GAMMA AUTORADIOGRAPHY OF HIGH PERFORMANCE PELLET AND POWDER FUEL. Weidenbaum, B.; Coplin, D. H.; Lyons, M. F. (General Electric Co., Pleasanton, Calif. Vallecitos Atomic Lab.). Oct. 1966. Contract AT(04-3)-189. 79p. (EURAEC-1888). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

A selected group of α and $\beta-\gamma$ autoradiographs obtained routinely during examination of fuel rods irradiated in the PWL with varying degrees of central melting were studied in some detail. The group includes autoradiographs of pellet and powder fuels irradiated to low burnup, and also to extensive burnup, without incident. Autoradiographs are also included of an instance in which molten fuel reached the cladding and one in which perforation of the cladding occurred while the test reactor was being brought to full power. Practical considerations limited the extent to which both techniques could be developed during this program. Even so, the $\beta-\gamma$ autoradiographs proved to be useful in obtaining a qualitative picture of fission product distribution within the fuel. Although consideration was given to the possibility of eventually developing procedures to give quantitative significance to the $\beta-\gamma$ autoradiographs, there are inherent limitations in obtaining this goal that are imposed by the use of photographic emulsions. These relate to the diverse source of ionizing particles and radiation present in the irradiated fuel and the broad energy spectra associated with each. Under these circumstances, the development effort was directed primarily to obtaining a technique that would provide $\beta-\gamma$ autoradiographs of general utility. Procedures for developing and particularly for bleaching the developed emulsion were empirical and were directed to obtaining processed emulsions that were useful in the qualitative sense. Although α autoradiography is free of the problems associated with the use of emulsions, the track etching technique used in α autoradiography is better suited for quantitative work when used for a more homogeneous source of α particles than is found in irradiated UO_2 fuel. The α radiographs described were particularly useful for defining the boundary to which the fuel melted during irradiation and for characterizing the location of plutonium and other transuranic nuclides. Recent developments in scintillation detectors with higher resolving power and the availability of the electron microprobe provide tools that are undoubtedly more useful than $\beta-\gamma$ autoradiography for identification and determination of the amount of fission products in irradiated fuel. The use of α autoradiography, however, can undoubtedly be extended in the area of nuclide characterization by the use of absorbers, and possibly, even in the area of quantitative estimation of the heavy nuclides beyond Pu. The use of both autoradiographic techniques can be expected to continue for qualitative characterization of irradiated fuel because the techniques are quite simple and the information obtained from the autoradiographs is useful. (auth)

36915 (LA-tr-67-41) STANDARD HEATS OF FORMATION OF THE CARBIDES OF TANTALUM OF THE PHASE TaC. Kornilov, A. N.; Zaikin, I. D.; Skuratov, S. M.; Dubrovskaya, L. B.; Shveikin, G. P. Translated by A. D. Cernicek (Los Alamos Scientific Lab., N. Mex.), from Zh. Fiz. Khim., 41: 346-50(1967). 13p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Dependence of standard heat of formation of TaC on the composition was found. Within the accuracy limits of experiment, it is linear and is expressed by the equation: $-\Delta H^0_{sample\,TaC_x} = 14.13 + 19.73 \cdot x$. (auth)

36916 RADIOACTIVE TRACER MEASUREMENTS OF IMPURITY ATOM MIGRATION IN SOLIDS UNDER EQUILIBRIUM CONDITIONS. Masters, B. J.; Fairfield, J. M. (IBM Components Div., Hopewell Junction, N. Y.). Trans. Amer. Nucl. Soc., 10: 75-6(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36917 HIGH-STRENGTH, HIGH-MODULUS GLASS FIBERS. Lewis, Albert; Robbins, David L. (Aerojet-General Corp., Azusa, Calif.). J. Polym. Sci., Part C, No. 19, 117-50(1967).

Work was conducted to develop high-strength, high-modulus glass fibers. Statistical experimental design and data analysis were used to determine some of the sampling, testing, and fiberizing variables that affect the dispersion of mechanical property data of glass fiber specimens. The simplex lattice experimental design was used in glass compounding studies. The experimental method is described. Three glass compositions with high mechanical properties are described. One of these glasses is composed of $MgO-Al_2O_3-SiO_2$. The other two are 4-component glasses and contain $MgO-Al_2O_3-SiO_2$ and BeO, or La_2O_3. (auth)

36918 THE THERMAL CONDUCTIVITY OF UO_2-SiO_2 VITRO CERAMICS IN THE TEMPERATURE RANGE 100 TO 400°K. Luscal, N. (Inst. for Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 469-77(1967).

The thermal conductivity of the SiO_2-UO_2 system at concentration of 70, 60, 50, 40, and 30% mol UO_2 and of SiO_2 was measured at 100 to 400°K. Data analysis showed that the conductivity values of the system are small in comparison with those of UO_2, being rather close to the ones of SiO_2; it is admitted that the thermal conductivity of the system is mainly determined by the SiO_2 phase. The results also suggest that at 60 mol % UO_2 the SiO_2 phase is continuous, while the UO_2 one is dispersed through it. (auth)

36919 CEMENTED CARBIDES WITH HIGH-MELTING BINDERS. II. TERNARY EQUILIBRIUM SYSTEMS. Hodson, R. L.; Parikh, N. M. (IIT Research Inst., Chicago). Int. J. Powder Met., 3: No. 3, 31-40(July 1967).

Ta-Zr-C, Nb-Zr-C, Ta-Ti-C, Nb-Ti-C, Ti-Zr-C, Hf-Zr-C, Hf-Ti-C, Ti-V-C, Nb-V-C, Ti-Al-C, Hf-Mo-C, and Hf-Ta-C systems were investigated as potential cutting-tool materials. Two-phase alloys were prepared by liquid-phase sintering and by arc melting; mechanical-property measurements were made, and promising materials were subjected to lathe-turning tests. Ti-V-C and Nb-V-C alloys appear highly promising compared to other cutting-tool materials. (auth)

36920 THERMAL CONDUCTIVITY AND HEAT CAPACITY OF THE MONOCARBIDE, MONOPHOSPHIDE, AND MONOSULFIDE OF URANIUM. Moser, J. B.; Kruger, O. L. (Argonne National Lab., Ill.). J. Appl. Phys., 38: 3215-22(July 1967).

The heat-transport properties and heat capacity of UC, UP, and US were determined between room temperature and 600°C. These properties were measured by a transient technique with a laser as a heat pulse source. The thermal conductivity was calculated from the product of the thermal diffusivity, heat capacity, and density. At room temperature the thermal conductivity of the three compounds corrected to theoretical density was found to be 0.057, 0.033, and 0.021 cal sec^{-1} cm^{-1}°C^{-1} for UC, UP, and US, respectively. At 600°C the value for UC decreased to 0.041 cal sec^{-1} cm^{-1}°C^{-1}. The thermal conductivity of UP remained equal to its room-temperature value and that of US increased to 0.029 cal sec^{-1} cm^{-1}°C^{-1}. The room-temperature heat capacity values for the three compounds investigated were all slightly above 12 cal $mole^{-1}$°K^{-1}. At 600°C the heat capacity of UC increased to 15.2 cal $mole^{-1}$°K^{-1}, whereas no appreciable changes were found for UP and US at this temperature. The experimental heat-capacity values were used to formulate expressions of the type $C_p = a + bT + cT^{-2}$ with the aid of a computer program, and enthalpies and entropies of the compounds were calculated from 400 to 1000°K. The electronic contributions to the thermal conductivities of the three compounds were calculated by means of the Wiedemann-Franz law with the Lorenz constant for metallic conductors. The limitations of this approach are discussed and an alternate method of separating the phonon from the electronic part of the thermal conductivity is presented. A value of 0.02 cal sec^{-1} cm^{-1}°C^{-1} for the lattice conductivity alone was obtained. This value is close to the 0.01 to 0.02 cal sec^{-1} cm^{-1}°C^{-1} obtained by using the Wiedemann-Franz law on UP and US. The thermal conductivity of UC above 300°C can be ascribed to electrons if the traditional Lorenz constant is used. However, comparison of the thermal and electrical conductivity for the three compounds indicates that the Lorenz number when applied to UC should be lower, possibly because of the presence of optical scattering. It was found that the lattice resistance to the flow of heat in this group of compounds is essentially temperature independent and that calculations based on the classic models do not give good agreement with measured values. (auth)

36921 INVESTIGATIONS ON CRYSTALS HAVING THE COMPOSITION $ZrO_2.2MoO_3$. Kleber, W.; Doerschel, J. (Humboldt Univ., Berlin). Z. Anorg. Allg. Chem., 347: 289-93 (Nov. 1966). (In German).

Morphological and x-ray studies were performed on the crystals encountered in the $ZrO_2-Li_2MoO_4-MoO_3$ system. The primary phase crystallizing from this melt is $ZrO_2 \cdot 2MoO_3$. Five phases were encountered at temperatures of 150, 495 (two phases), 625, and 885°C, respectively. The crystal-structure parameters of these phases are presented and discussed. In addition, data on thermal behavior were determined. (JPRS)

36922 THE ELECTRIC CONDUCTIVITY IN THE ZrO_2-CaO AND ZrO_2-MgO SYSTEMS. PART 2. Moebius, Hans-Heinrich

(Univ., Greifswald, Ger.). Silikattechnik, 17: 385-7(Dec. 1966). (In German).

The effects of concentration and temperature on conductivity in the ZrO_2–CaO system, the differences between the CaO- and MgO-containing systems, and a review of the pertinent literature are considered. (104 references). (JPRS)

36923 THE NATURE AND EFFECTS OF EXCESS CARBON DEFECTS IN TUNGSTEN CARBIDE–COBALT ALLOYS ON MECHANICAL PROPERTIES. French, David N.; Thomas, David A. (Ingersoll-Rand Co., Princeton, N. J.). Int. J. Powder Met., 3: No. 3, 7-14(July 1967).

A mechanism is presented for the formation of excess carbon defects during sintering and solidification of WC–Co alloys. Water vapor or O impurities in the H_2 atmosphere react with graphite sintering boats to transport C through the gas phase to the alloy surface. C then diffuses inward through the liquid Co, with a diffusion coefficient estimated to be between 2.5×10^{-4} and 10^{-4} cm^2/sec. When solidification of the Co binder is nearly completed, the excess C precipitates as graphite from the liquid remaining between the solid Co regions. From the spacing between the graphite areas, the Co grain size is estimated at about 0.5 mm. The excess C defects serve as internal stress raisers and reduce the transverse rupture strength of WC-10 wt % Co test specimens. (auth)

36924 EFFECTS OF CARBON CONTENT ON THE PROPERTIES OF TUNGSTEN CARBIDE–TANTALUM CARBIDE–10 PERCENT COBALT CEMENTED CARBIDE. Suzuki, Hisashi; Yamamoto, Takaharu (Tokyo Univ.). Int. J. Powder Met., 3: No. 3, 17-27(July 1967).

The effects of the C and TaC content on the various properties of WC–TaC–10% Co alloys were investigated. The compositions of binder and TaC phases, mechanical properties, structures and phase diagram, etc., were examined. (auth)

36925 ENTHALPY AND THERMAL CAPACITY OF NIOBIUM AND ZIRCONIUM CARBIDES AT 500 TO 2400°K. Kantor, P. B.; Fomichev, E. N. (Kharkov Inst. of Measures and Measuring Instruments). Teplofiz. Vys. Temp., 5: 48-51(Jan.-Feb. 1967). (In Russian).

The enthalpy of NbC (molar weight—104.921 g) and ZrC (molar weight—103.231 g) has been determined experimentally at 500 to 2400°K. The enthalpy of NbC at 516.2 to 2375.0°K was 2219 to 26,179 cal/mole, and that of ZrC at 514 to 2304°K was 2264 to 24,905 cal/mole. On the basis of obtained results, the heat capacity of NbC was also calculated. The values of enthalpy and heat capacity compared within 0.5 to 1.5% with those calculated theoretically and those obtained by other researchers. (ATD)

Structure and Phase Studies

36926 (BNWL-SA-767) CONTACT MICRORADIOGRAPHY OF GRAPHITE. Dunnell, L. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [nd]. Contract AT(45-1)-1830. 12p. (CONF-670605-3). Dep. CFSTI.

From 70th Annual Meeting of the American Society for Testing and Materials, Boston, Mass.

Contact microradiography was used to define and characterize the microstructure of graphite. Long wavelength x rays were used to examine microcracks and other structural features of graphite specimens 20 μ thick. The microcrack structure and coke particle orientation were clearly visible. Direct observation of the surface did not fully define these microcracks. The technique was also used to locate and characterize very small amounts of metal carbides in graphite–metal systems. For example, 10 μ particles of UC_2 were located in graphite specimens where photomicrography showed no carbide. Vacuum impregnation with liquids opaque to certain wavelengths proved useful in defining graphite pore structure. If tetrabromoethane, for example, is used, short wavelength x-rays provide an image of only the filled pores. Longer wavelengths then show unfilled pores. Mixing resins with the tetrabromoethane immobilizes it in the specimen. Impregnating bulk samples with this mixture before sampling permits the investigation of possible access routes for chemical attack. (auth)

36927 (CALT-221-33) SIMPLE CUBIC AND AMORPHOUS PHASES IN TELLURIUM-BASE ALLOYS WITH COPPER, SILVER, AND GOLD. Report No. 51. Tsuei, C. C.; Duwez, Pol (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). June 1967. Contract AT(04-3)-221. 13p. Dep. CFSTI.

Phase relations were studied in three pseudo-binary alloy systems involving two of the three phases $Te_{70}Cu_{30}$, $Te_{70}Ag_{30}$ and $Te_{70}Au_{30}$. The systems were prepared by melting appropriate quantities of the components in quartz crucibles under ar argon atmosphere. The metastable phases were obtained by rapid quenching from the liquid state. Variations in lattice parameter with composition are shown. (M.C.G.)

36928 (CEA-R-3229) ETUDE DES COMPOSES URANIUM–PLUTONIUM–CARBONE–MOLYBDENE. (Studies of U–Pu–C–Mo Compounds). Boucher, Rene; Barthelemy, Pierre (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Apr. 1967. 34p. (In French). Dep.

The U–Pu–C–Mo compounds (5 to 10 at.% Mo) were studied in order to improve some properties of U–Pu–C compounds. The Pu/U + Pu ratio was fixed to 15%. The alloys were melted and casted in an arc furnace. The introduction of Pu caused little change in the structure of the U–C–Mo system. Two intermetallic compounds $(U,Pu)MoC_2$ and $(U,Pu)MoC_{1.7}$ were found. Three fields of phases were particularly studied: (a) (U,Pu)C + Mo; (b) (U,Pu)C + $(U,Pu)MoC_2$; and (c) (U,Pu) + $(U,Pu)MoC_{1.7}$ + Mo. With regard to (U,Pu)C, the following properties are improved: the manufacturing process, resistance to air corrosion, compatibility with stainless steel at 950°C. Thermal conductivity at high temperatures was improved with the alloys of types (a) and (c). The alloys (a) have the best properties but unfortunately they are placed in a very narrow domain of composition. In conclusion, the alloys (c) are the most attractive. (auth)

36929 (IS-Trans-56) INVESTIGATION OF THE INTERACTION OF THORIUM CHLORIDE WITH THE CHLORIDES OF MAGNESIUM, CALCIUM, CERIUM, ALUMINUM, IRON, NIOBIUM, TANTALUM, AND THE OXYCHLORIDE OF NIOBIUM IN MELTS. Korshunov, B. G.; Ionov, V. I.; Baklashova, T. A.; Kokorev, V. V. Translated by E. E. Conrad (Ames Lab., Iowa), from Izv. Vyssh. Ucheb. Zaved., Tsvet. Met., 4: No. 6, 114-18(1960). 10p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The systems $ThCl_4$–$MgCl_2$, $ThCl_4$–$CaCl_2$, $ThCl_4$–$CeCl_3$, $ThCl_4$–$AlCl_3$, $ThCl_4$–$FeCl_2$, $ThCl_4$–$NbCl_5$, $ThCl_4$–$NbOCl_3$, $ThCl_4$–$TaCl_5$, and $ThCl_4$–$FeCl_3$–$NbCl_5$ were studied by thermal analysis. Tensiometric analysis was carried out for separate melts of the systems indicated. Composition diagrams of the systems belong to the eutectic type. The absence of chemical interaction between the components and difference in the vapor pressure may be used for separation of the components. (auth)

36930 NIOBIUM–NICKEL–BORON SYSTEM. Sobolev, A. S.; Kuz'ma, Yu. B.; Fedorov, T. F. (Inst. of Metallurgy, Moscow. Lvov State Univ.). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 638-43(Apr. 1967). (In Russian).

A study was made of 88 alloys of the Nb–Ni–B system. Alloys were melted from 98.6%-pure B, 99.7%-pure Nb and 99.7%-pure Ni. A phase equilibrium diagram of the system at 950°C was plotted on the basis of data obtained. The existence of $Nb_2Ni_{21}B_6$ (τ-phase) and $NbNiB_2$(γ-phase) compounds was confirmed. Two previously unknown compounds, $Nb_3Ni_{11}B_4$(Z-phase and $Nb_2NiB_{0.16}$ (β-phase), were also found. (ATD)

36931 MASS-SPECTROMETRIC STUDY OF VAPOR COMPOSITION OVER TiC–C AND ZrC–C SYSTEMS. Starostina, T. S.; Sidorov, L. N.; Akishin, P. A.; Karasev, N. M. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 727-8 (Apr. 1967). (In Russian).

An MS-1 mass spectrometer, modified to meet the requirements of high-temperature thermodynamic studies, was used to investigate the composition of the vapor over TiC–C and ZrC–C systems. In the TiC–C system, Ti^+, C_2^+, and C_3^+ ions were detected. From the temperature dependence of the Ti^+ ion current, the heat of sublimation of Ti from the TiC–C system was found to be 155.9 ± 7.9 kcal/mole. The Ti vapor pressure over this system at 2500°K was 1.0×10^{-3} mm. The free energy of formation of TiC from the elements was calculated to be −34.4 kcal/mole. The vaporization occurs as follows: $TiC_s \rightarrow Ti_{gas} + C_{graphite}$. In the ZrC–C system, the heat of sublimation of Zr for two series of experiments was found to be 141.2 ± 3.1 and 145.4 ± 4.2 kcal/mole. The Zr vapor pressure at 2000°K is 3.7×10^{-6} mm. Zr^+, C_2^+, C_3^+, and ZrC_2^+ ions were recorded in the mass spectrum at 2660°K. The free energy changes in the reactions $ZrC_{2gas} \rightarrow Zr_{gas} + C_{2gas}$ and $ZrC_s \rightarrow Zr_g + C_s$ were found to be −26.0 and −38.2 kcal/mole, respectively. Small quantities of ZrC_2 molecules are shown to be present in the saturated vapor over the ZrC–C system in addition to Zr, C, C_2, and C_3. (ATD)

36932 STANDARD ENTHALPY OF FORMATION OF La_2Te_3, In_2Te_3, AND $LaInTe_3$. Sharifov, K. A.; Karaev, Z. Sh.; Azizov, T. Kh. (Inst. of Physics, Baku). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 719-20(Apr. 1967). (In Russian).

The enthalpy of formation of $LaInTe_3$ and its binary compounds was determined and the stability of $LaInTe_3$ was analyzed. The tabulated data for enthalpy of formation of In_2Te, La_2Te_3, and $LaInTe_3$ showed that $\Delta H^0_{298}(In_2Te_3) = -50.3 \pm 2.0$ kcal/mole (210.06 ± 8.37 J/mole), $\Delta H^0_{298}(La_2Te_3) = -187.5 \pm 6.1$ kJ/mole (784.50 ±

25.52 kcal/mole, and $\Delta H^0(LaInTe_3) = 135.4 \pm 6.6$ kcal/mole (566.51 ± 27.61 kJ). The thermal effect of the reaction is: $\frac{1}{2}$ La_2Te_3 + $\frac{1}{2}$ In_2Te_3 → $LaInTe_3$ + 16.5 kcal. The maximum temperature of the synthesis was 950 to 1000°C which is lower than the melting point for La_2Te_3(~1450°C) and $LaInTe_3$(1120°C). (R.V.J.)

36933 EFFECT OF ISOSTATIC PRESSURE ON SINTERING. Morgan, C. S.; Hall, L. L. (Oak Ridge National Lab., Tenn.). J. Amer. Ceram. Soc., 50: 382-3(July 21, 1967). (ORNL-P-2989).

Experiments are described in which cold-pressed highly sinterable oxide powder compacts were partially sintered. The partially sintered compacts were then isostatically pressed and resintered. Densification during the second heat treatment was compared with that expected without the isostatic pressing step. Observations suggesting dislocation contribution during the initial phases of sintering are discussed. Data are included on ThO_2 and ThO_2–CaO densification. (J.R.D.)

36934 THE SYSTEM Y_2O_3–V_2O_5. Levin, Ernest M. (National Bureau of Standards, Washington, D. C.). J. Amer. Ceram. Soc., 50: 381-2(July 21, 1967).

A phase diagram of this oxide system is presented and discussed. (J.R.D.)

36935 DECOMPOSITION KINETICS OF $CaYb_2O_4$. Barry, Thomas L.; Stubican, V. S.; Roy, Rustum (Pennsylvania State Univ., University Park). J. Amer. Ceram. Soc., 50: 375-8 (July 21, 1967).

The kinetics of decomposition of $CaYb_2O_4$ were studied using quantitative analysis by x-ray diffraction methods and a modified method of standard binary mixtures. This type of method was required as total composition remained constant with only the phase assemblage changing. The experimental factors considered in obtaining meaningful results from such a procedure are covered. The linearity of the fraction decomposed or concentration unreacted versus time curves at various temperatures revealed that the decomposition proceeded according to zero-order kinetics. The activation energy for this process was 100 kcal/mole. (auth)

36936 NUCLEATION AND CRYSTALLIZATION OF $NaNbO_3$ FROM GLASSES IN THE Na_2O–Nb_2O_5–SiO_2 SYSTEM. Layton, M. M.; Herczog, Andrew (Corning Glass Works, Corning, N. Y.). J. Amer. Ceram. Soc., 50: 369-75(July 21, 1967).

Transparent glass-ceramics, in which the major phase was $NaNbO_3$, were obtained by heat treatment of glasses in the Na_2O–Nb_2O_5–SiO_2 system. The structure of the glass and the changes occurring during crystallization as a function of temperature and heating rate were examined by x-ray diffraction, transmission, and replication electron microscopy, density, and other measurements. On heating, a rather abrupt formation of uniformly dispersed particles was observed. In the early stages of crystallization, these particles contained $NaNbO_3$ as loose, radially grown dendrites of identical crystal orientation which became dense during later stages of crystallization. The particle sizes ranged from 200 to 10,000 Å, depending on the SiO_2 content of the glass. Transparency of the crystallized material was dependent on the particle size rather than on the amount of $NaNbO_3$ formed. The temperature at which crystallization occurred increased with the heating rate whereas the viscosity at crystallization decreased. For a given value of the rate of crystal formation per °C of temperature increase, the product $(\text{viscosity})^n \times (\text{heating rate})$ was constant. The nucleation and growth phenomena which occurred in these glasses were attributed to microheterogeneities of higher Nb_2O_5 content which formed part of the glass structure. (auth)

36937 ANALYSIS OF THE CRYSTAL STRUCTURE AND MAGNETIC STRUCTURE OF THE FERBERITES $FeWO_4$. Uelkue, Dincer (Univ., Munich). Z. Kristallog., 124: 192-219(June 1967). (In German).

The structure parameters of ferberite $FeWO_4$ were determined from x-ray and neutron-diffraction measurements. The least-squares refinement method was used to refine the parameters obtained from a three-dimensional difference Fourier synthesis. The metal ions (Fe^{2+} and W^{6+}) occupy one half of the octahedral holes in a slightly deformed hexagonal closest-packed lattice of O atoms. The structure is identical to the structure of $NiWO_4$ other than for small parameter variations. It was shown by the neutron-diffraction measurements at 4.2°K that the ferromagnetically planes (100) were antiferromagnetically ordered parallel along the x axis. All of the moments lie parallel in the plane (010). They build an angle of 29° with the x axis and are not perpendicular to any of the octahedral faces. The magnitude of the moment (2.19 μ_B) for a Fe^{2+} ion corresponds approximately to the four unpaired electrons of the Fe^{2+} ions when one considers only the spin components. The antiferromagnetic transition temperature was found to be 66°K for ferberite. (auth)

36938 MICROSTRUCTURES OF COLUMNAR GRAINS IN URANIUM DIOXIDE. Kubota, Tadashi (Mitsubishi Atomic Power Industries, Inc., Ohmiya, Japan). Trans. Jap. Inst. Metals, 8: 3-7(Jan. 1967).

Microstructures of columnar grains of UO_2 grown under the temperature gradient — sintered pellets, swaged compacts and vibratory compacts — below the melting point were studied by optical and electron micrography. It was found that the dominant mechanism in columnar grain growth varies with porosity. The columnar grains in high-density sintered pellets of 97% theoretical density are considered to be grown by the migration of grain boundary. As the porosity increases, the migration of large voids plays a dominant role in the columnar grain growth. In addition to lenticular voids, voids or gaps along the grain boundary of columnar grains are observed in porous specimens. As for the powder compacts of the same composition and different compact densities, the size and number of lenticular voids increase with decreasing density. (auth)

36939 OPTICAL PROPERTIES OF RARE EARTH ELEMENTS. V. STUDIES OF MONOCLINIC MODIFICATIONS (β-SHAPE). Ruchkin, E. D.; Sokolova, M. N.; Batsanov, S. S. (Inst. of Thermophysics, Novosibirsk, USSR). Zh. Struct. Khim., 8: 465-70(May-June 1967). (In Russian).

Refractometric, ir-spectroscopic, and x-ray studies were made of the monoclinic β-form oxides of Dy, Gd, Ho, Er, Tm, Yb, Lu, and Y, prepared by shock compression attained by an explosion. The phase transitions and thermal inverse transformation into C-form are discussed and properties of all initial cubic C-forms are analyzed. (tr-auth)

36940 HIGH-TEMPERATURE X-RAY DIFFRACTION STUDIES IN SELECTED RARE EARTH OXIDE–OXYGEN SYSTEMS. Burnham, Daniel Arthur. Tempe, Ariz., Arizona State Univ., 1967. 199p.

Thesis.

High-temperature x-ray diffraction was used to study the stability regions of intermediate phases in the systems, Pr_2O_3–O_2, Tb_2O_3–O_2, and Ce_2O_3–Tb_2O_3–O_2. Lattice parameters were determined by a least-squares analytical treatment with the aid of a CDC 3400 Computer. Isobaric studies of the Pr_2O_3 and Tb_2O_3 systems, in which the reaction path was traced in reduction on heating, then in oxidation on cooling, showed that single phases existed in single-phase regions indicated by previous tensimetric studies, and that two phases existed in diphasic regions. The presence of hysteresis was confirmed. In all hysteresis loops examined, two phases were present. A dissymmetry in the hysteresis loops between reduction and oxidation paths was manifested; if a disorder → order transformation was involved, the diphasic temperature range was extended. X-ray isothermal studies were also made to examine hysteresis effects. Again, it was shown that hysteresis loops encompassed diphasic regions. It was possible with these studies to show that the composition of the ordered phases of narrow homogeneity range in diphasic regions remains virtually constant. X-ray diffraction traces also showed that the pseudo phases seen in oxidation were diphasic mixtures of the two same phases seen in reduction. In the ternary system, $Ce_{0.3}Tb_{0.8}O_x$, studied, no diphasic regions were observed. The resolution found in x-ray patterns of Tb_2O_3 which distinguished the different phases, was lost when Ce_2O_3 was admixed. Line broadening in the x-ray diffraction patterns was thought to be a combination of valency change of the Tb in the mixed oxide and variations in inhomogeneities of the crystallites because of the presence of Ce. High-temperature x-ray diffractometry was effective in determining the stability regions of ordered phases and disclosing the constituent phases in diphasic regions. The effectiveness was increased when x-ray diffraction was used in conjunction with thermogravimetric analyses. (Disser. Abstr.)

Radiation Effects

Refer also to abstracts 36307 and 36914.

36941 (BNWL-380) EFFECT OF IMPREGNATION AND CRYSTALLITE ORIENTATION ON THE RADIATION INDUCED CONTRACTION OF GRAPHITE. Cox, J. H. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1967. Contract AT(45-1)-1830. 22p. Dep. CFSTI.

Effects of crystallite orientation and impregnant level on radio-induced bulk contraction in polycrystalline graphite were studied. Radiations reached a maximum exposure of 1.3×10^{21} nvt (E > 0.18 MeV) in a temperature range of 500 to 700°C. The description of graphite as a single-phase material effected a correlation between crystallite orientation and dimensional changes in a series of samples that were identical except for the degree of anisotropy. However, increasing the impregnant level increased the dimensional

changes and showed that the single-phase description was inadequate as a completely general method of characterizing the radiation behavior of graphite. (auth)

36942 (EURAEC-1869) URANIUM MONOCARBIDE SHAPING AND IRRADIATION. Quarterly Report No. 21, July 1-September 30, 1966. Devillard, J.; Morlot, G. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Contract 7589. 34p. (EUR-3373). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The June 1966 irradiation of 8% ^{235}U-enriched UC yielded three findings: the NB wool around the specimens is effective and eliminates NaK convection; the capsule structure precludes long-term irradiation in NaK at 1000°C; and the irradiation is not isothermal. A NaK temperature of 1000°C corresponds in practice to a specimen core temperature between 1600 and 1800°C. With a specific power of 2000 W/cm^3, this excessive temperature seems to explain the specimen fragmentation in the initial hours of irradiation. A natural UC fuel pin is being irradiated. The UC-Nb contact thermal resistance is close to 0.6. o/w cm^2. The mean thermal conductivity at temperatures between 300 and 600°C seems to lie in the 0.16 w/cm°C range. (auth)

36943 (EURAEC-1870) URANIUM MONOCARBIDE SHAPING AND IRRADIATION STUDY. Quarterly Report No. 22, October 1-December 31, 1966. Devillard, J.; Morlot, G. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Contract 7589. 23p. (EUR-3374). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The Sil-4 irradiation was placed in the Siloé Reactor in November 1966, with a mean surface temperature of 950°C, i.e., the core temperature of the 8% ^{235}U-enriched fuel was approximately 1600°C. Neutrographs showed no sample deterioration. The irradiation is taking place normally. E1 irradiation functioning was stable. It will be withdrawn from the E1-3 reactor in January 1967 when it will have attained a burnup ratio of close on 1200 MWd/t. The CYRANO irradiation technology is described. It will be conducted on a 2% enriched UC rod with a diameter of 30 mm and a length of 150 mm. A 1350°C core temperature can be expected with a surface temperature of 600°C and a conductivity integral exceeding 100 W/cm. (auth)

36944 (GEMP-537) THE NONDESTRUCTIVE DETERMINATION OF THE DYNAMIC ELASTIC CONSTANTS OF BeO. Clark, J. P.; Osborne, J. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). July 31, 1967. Contract AT(40-1)-2847. 13p. (CONF-651125-2). Dep. CFSTI.

From Seminar on Determination of Physical Properties of Materials through Sonic Resonant Methods, Columbus, Ohio.

Sonic and ultrasonic resonant-frequency techniques to determine the dynamic elastic constants of extruded BeO rods are presented. Special techniques and equipment for measuring the fundamental and harmonic frequencies of the flexural, longitudinal, and torsional modes of vibration of short rods are discussed. Data were collected involving the elastic constants of several types of BeO with and without additives, as a function of temperature, density, grain size, and neutron irradiation. Additional data showing the relation between the fundamental resonant peaks and corresponding high harmonics are discussed. (auth)

36945 PERFORMANCE OF PYROLYTIC-CARBON-COATED SOL-GEL UO_2 MICROSPHERES IN HIGH-BURNUP IRRADIATION TESTS. Olsen, A. R.; Coobs, J. H.; Hewette II, D. M.; Krautwedel, H. L.; Longest, A. W.; Long, E. L. Jr.; Prados, J. W.; Scott, J. L. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 96-7(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36946 FUEL MIGRATION INTO COATINGS OF PYROLYTIC-CARBON-COATED UO_2 AND UC_2 PARTICLES AS A RESULT OF IRRADIATION AND HEAT TREATMENT. Morgan, M. T.; Long, E. L. Jr.; Hewette II, D. M. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 97-8(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36947 FISSION-PRODUCT RELEASE DURING POSTIRRADIATION ANNEALING OF PYROLYTIC-CARBON-COATED FUEL PARTICLES. Morgan, M. T.; Sisman, O. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 98(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36948 IRRADIATION DAMAGE TO HIGH-DENSITY ALUMINUM OXIDE EXPOSED TO FAST-NEUTRON DOSES UP TO 5×10^{21} n/cm^2. Ketlholtz, G. W.; Moore, R. E. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 117(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

36949 HIGH-TEMPERATURE ANNEALING OF DEFECTS IN SILICON IRRADIATED BY FAST NEUTRONS. Lugakov, P. F.; Sevchenko, A. N.; Tkachev, V. D. (Belorussian State Univ., Minsk). Dokl. Akad. Nauk BSSR, 11: 104-6(Feb. 1967). (In Russian).

Large integral doses of fast neutrons (up to 5×10^{18} cm^{-2}) were imparted to n-type single-crystal Si having initial resistances of 0.03, 7.8, 25, and 100 ohm-cm. A study of the electrical characteristics of the irradiated samples showed that the samples with initial resistances of 7.8, 25, and 100 ohm-cm changed their type of conductivity, while the sample with a resistance of 0.03 ohm-cm retained its n-type conductivity. The samples were annealed up to temperatures of 500 to 600°C with subsequent measurement of their electrical characteristics. The behavior of the 25 ohm-cm sample was typical. On heating to 150°C, the electrical resistance fell due to recombination of radiation defects and a decrease in current carrier mobility. At 300°C annealing of adherence centers of secondary carriers led to a decrease in concentration of principal carriers (of holes) in the valence zone. The activation energy for this process was equal to 1.30 ± 0.13 eV. Further annealing up to 550 to 600°C showed a gradual decrease in number of defects. The activation energy for this stage, where most of the defects were annealed out, was 3.1 ± 0.3 eV. The activation energy for annealing of the A-center was 2.2 ± 0.3 eV at about 450°C as the annealing temperature. (TTT)

36950 γ-IRRADIATION EFFECT ON THE THERMAL CONDUCTIVITY OF Al_2O_3 WITH Cr OR Mn IMPURITIES AT LOW TEMPERATURE. de Goer, A. M.; Dreyfus, B. (Centre d'Etudes Nucleaires, Grenoble, France. Centre de Recherches sur les Tres Basses Temperatures, Grenoble, France). Phys. Status Solidi, 22: 77-82(July 1, 1967).

The effect of γ-irradiation on the thermal conductivity of samples of Mn or Cr-doped Al_2O_3 is measured between 1.3 and 300°K. Ions with an even number of electrons (particularly those with the Mn^{3+} configuration) are much more effective in scattering phonons than Kramers' ions. Comparison of the experimental data therefore strongly suggests the presence of Cr^{2+}, isoelectronic of Mn^{3+}, in irradiated ruby. A preliminary study of the thermal annealing shows that the recovery of the thermal conductivity is rather complicated. (auth)

36951 LABORATORY AND FLIGHT TEST PROGRAM TO EVALUATE THE SPACE STABILITY OF HIGHLY SPECULAR REFLECTIVE SURFACES. Marshall, K. N.; Douglas, N. J.; Pollard, H. E.; Rolling, R. E. (Lockheed Palo Alto Research Lab., Calif.). Contract AF 33(615)-1577. J. Spacecraft Rockets, 4: 912-19(July 1967).

A program designed to determine the stability of solar concentrator reflective surfaces in a low-altitude, polar orbital environment is described. The laboratory portion of the program determined effects of 5-keV electrons, 2-keV protons, ultraviolet radiation, and combined 5-keV electrons and ultraviolet on several candidate reflective coatings. Results of the laboratory tests provided a basis for selection of the most promising reflective coatings to be flight tested. Uncertainties in exact definition of the space environment and practical difficulties in simulation of the total environment make flight tests necessary for final evaluation of the stability of the reflective surfaces. The flight test instrument package, scheduled for launch aboard a P-11 satellite during 1967, consists of a reflectance degradation instrument and a set of segregated environment calorimeters. The reflectance degradation instrument uses an integrating sphere principle to provide in-flight data on changes in specular, diffuse, and hemispherical reflectance. The calorimeters expose test samples to various controlled combinations of the space environmental components and provide data from which changes in solar reflectance and infrared emittance can be determined. (auth)

Plastics and Other Materials

Refer also to abstract 36810.

36952 (GA-7450) COMPARISON TESTS ON CONCRETE DEFORMATION USING GENERAL ATOMIC ANDESITE AND DOLOMITE COARSE AGGREGATES COMPARED WITH WYLFA LIMESTONE. Report No. 148/66/1177. Blundell, R. (Taylor Woodrow Construction Ltd., Southall (England)). Apr. 1966. Contract AT(04-3)-633. 17p. Dep. CFSTI.

For General Dynamics Corp., San Diego, Calif. General Atomic Div.

The General Atomic andesite concrete specimens had a higher shrinkage rate than the Wylfa concrete for the short period between 7 and 28 days after casting; the andesite concrete shrank 74 μ as compared to 33 μ for the Wylfa concrete. Concrete cast with andesite aggregate appears to be a more elastic material than Wylfa limestone concrete. This apparent property is borne out by the lower initial E value of 4.5×10^6 lb/in.^{2} obtained for the andesite concrete, compared with the value of 5.5×10^6 lb/in.^{2} for the Wylfa limestone concrete. For a period of 2 days after loading, creep deformation was greater for the andesite concrete, but thereafter the creep rate was similar to that for Wylfa limestone concrete. In terms of the specific creep strain equation, $\epsilon = f(K\Theta) + f'(K\Theta) \log_{10} (1 + t)$, the andesite concrete gave a $f(K\Theta)$ value approximately 17% greater than the Wylfa material and a $f'(K\Theta)$ value 12% greater. For design purposes, until further data are available, the following corrections should be applied to the Wylfa creep program design estimate data given in GA-7440: the shrinkage curve factor given in Fig. 7.2 of that report should be multiplied by a factor of 2.25 and the $f(K\Theta)$ and $f'(K\Theta)$ in the specific strain data sheet, given in Fig. 2.8 of that report, should be multiplied by factors of 1.17 and 1.12, respectively. (auth)

36953 (SC-RR-67-478) MECHANICAL PROPERTIES OF IMPACTED SOLID POLYURETHANE. Butcher, B. M. (Sandia Corp., Albuquerque, N. Mex.). July 1967. 10p. Dep. CFSTI.

Plate impact experiments have been performed on 1.189 g/cc (solid) polyurethane to determine if visco-elastic effects can be detected within the velocity range of 0 to 1200 ft/sec. The results of the experiments indicate that deviations from anticipated behavior are small for the conditions investigated. Experimental techniques are described and data are presented in the form of stress-strain curves. (auth)

36954 THERMAL-NEUTRON-INDUCED RECOIL IN N-TYPE CADMIUM TELLURIDE. Barnes, Charles; Kikuchi, Chihiro (Univ. of Michigan, Ann Arbor). Trans. Amer. Nucl. Soc., 10: 115 (June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36955 EFFECTS OF RADIATION ON BEARING CAGE MATERIALS AND RETAINERS AT LIQUID-HYDROGEN ENVIRONMENT. Weleff, W.; Accinelli, J. B. (Aerojet General Corp., Sacramento, Calif.). Trans. Amer. Nucl. Soc., 10: 116-17 (June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

36956 THE EFFECTS OF TEMPERATURE AND PHOTON RADIATION ON THE ELECTRICAL BREAKDOWN OF LUCALOX. Peters, M. D.; Davis, M. V. (Univ. of Arizona, Tucson). Trans. Amer. Nucl. Soc., 10: 117-18 (June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

PHYSICS (GENERAL)

Astrophysics

Refer also to abstracts 35866, 36361, 37191, 37198, 37204, 37205, 37218, 37219, 37220, and 37754.

36957 (AD-656150) ASTROPHYSICAL PROBLEMS. Tombrello, T. A. (California Inst. of Tech., Pasadena). June 1967. 17p. (CONF-670615-2). CFSTI.

From Symposium on Nuclear Physics Research with Low-Energy Accelerators, College Park, Md.

A discussion is presented on the proton–proton chain in stellar interiors. An attempt is made to understand these nuclear reactions in sufficient detail to turn them to use in understanding the stellar fusion process. (W.D.M.)

36958 (ESRO-SP-6) ELECTROMAGNETIC RADIATION IN SPACE. Proceedings of the Third ESRO Summer School held in Alpbach, Austria, 1965. (European Space Research Organization, Alpbach (Austria). Summer School). Sept. 1966. 501p. Dep.

Separate abstracts were prepared for the 17 lectures presented. (W.D.M.)

For abstracts of individual papers see: 36959–36971 and 37189–37192.

36959 (ESRO-SP-6, Paper 1) INTRODUCTION TO ASTROPHYSICS. Van de Hulst, H. C. (Leiden Rijksuniversiteit (Netherlands)). 22p.

A general review is given on astronomy, some of its historical developments and present problems. The stars, their classification, and evolution are considered. Interstellar matter is discussed. Radioastronomical investigations and their results are dealt with. (auth)

36960 (ESRO-SP-6, Paper 2) THEORETICAL ASPECTS OF STELLAR ULTRAVIOLET RADIATION. Underhill, Anne B. (Utrecht Rijksuniversiteit (Netherlands)). 19p.

The theory of stellar atmospheres is reviewed. The most important characteristic quantities appearing in the computation of a model atmosphere are discussed. The basic equations used for these calculations are briefly derived. The treatment is then applied to derive the uv spectrum of early stars. The results of specific calculations are compared with observational data. (auth)

36961 (ESRO-SP-6, Paper 3) ULTRAVIOLET ASTRONOMY: OBSERVATIONAL ASPECTS. Wilson, R. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). 27p.

The scope of uv astronomy with satellite- and sounding rocket-borne telescopes is described. After a general review of the major astrophysical phenomena the conclusion is drawn that space astronomy should cover the whole wavelength range 912 to 3000 Å. A survey of the instrumentation includes telescopes, spectrometers, and detectors. Astronomical observations which have been carried out so far from space vehicles are reviewed. A short assessment of the relative merits of satellite observations vs sounding-rocket observations is presented. (auth)

36962 (ESRO-SP-6, Paper 6) ON THE THEORY OF SOLAR ULTRAVIOLET RADIATION. Pottasch, S. R. (Groningen Rijksuniversiteit (Netherlands)). 12p.

The subject of the lecture is covered by a review article of the author. The purpose of the present notes is to give some complementary information by reviewing the methods of determining experimentally the electron density and temperature of the upper solar atmosphere. (auth)

36963 (ESRO-SP-6, Paper 7) OBSERVATIONS OF SOLAR ULTRAVIOLET RADIATION. Hinteregger, H. E. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). 9p.

A brief discussion is given of the main scientific objectives of present-day solar uv observations. The most important instrumental problems are reviewed. The opinion is stated that several comparatively simple satellites seem to be better suited for investigating the solar uv spectrum than a very complex spacecraft carrying many sophisticated experiments. (auth)

36964 (ESRO-SP-6, Paper 8) THEORETICAL ASPECTS OF EXTRATERRESTRIAL X RAYS OF NON-SOLAR ORIGIN. Biermann, L. (Max-Planck-Institut fuer Physik und Astrophysik, Munich (West Germany)). 19p.

Stars as possible sources of x rays with wavelength between about 10 and 100 Å are discussed. The crucial question is under what conditions do stars possess a corona which would emit quasi-thermal x rays in this range, similar to the sun. It is shown that with somewhat improved instruments, we could probably detect x-ray fluxes from a number of bright stars. A list of such stars is included. The production of hard x rays (below 10 Å) by bremsstrahlung and synchrotron radiation in various celestial bodies, as well as by thermal radiation in neutron stars, is considered. On the basis of the scarce observational evidence it is difficult to rule out any of the production mechanisms considered. However, some of them appear more likely sources of detectable x-ray sources than others. (auth)

36965 (ESRO-SP-6, Paper 9) OBSERVATION OF STELLAR X-RAY SOURCES. Rossi, B. (Massachusetts Inst. of Tech., Cambridge). 65p.

The limitations of x-ray astronomy due to absorption and production of secondary photons in the atmosphere are discussed. Almost all measurements have to be conducted from rockets or satellites. The experiments which have been carried out so far are mentioned. The detectors employed (gas counters, scintillation crystals, and photoelectric devices) are described as well as ancillary instrumentation. The analysis of data obtained from rocket flights is extensively discussed. The results of the observations performed until now are presented and compared in detail. The present knowledge on extraterrestrial nonsolar x-ray sources is critically reviewed. (auth)

36966 (ESRO-SP-6, Paper 10) THEORETICAL ASPECTS OF CELESTIAL GAMMA RAYS. Luest, R. (Max-Planck-Institut fuer Physik und Astrophysik, Munich (West Germany)). 18p.

The implications of gamma-ray astronomy for astrophysics in general are mentioned. The main part of the lecture deals with the various mechanisms for the production and absorption of gamma rays in stars and the interstellar medium. The predicted flux values of celestial gamma rays, both isotropic and due to discrete sources, are presented. (auth)

36967 (ESRO-SP-6, Paper 11) CELESTIAL γ RAYS: OBSERVATIONAL ASPECTS. Hutchinson, G. W. (Southampton Univ. (England)). 18p.

The most important characteristic parameters of celestial γ rays, such as spectrum, angular distribution, and variations in time, are briefly reviewed. The various ways of observing γ rays are listed. The experimental results obtained so far are summarized. (auth)

36968 (ESRO-SP-6, Paper 12) THEORETICAL ASPECTS OF SOLAR X RADIATION. De Jager, C. (Sterrewacht Sonnenborg, Utrecht (Netherlands)). 25p.

After a short review of the parameters which are most important in the theory of solar x rays, the production of x rays by the quiet corona is discussed invoking the theory of radiation emission in an optically thin plasma. A comparison is made between theoretical predictions and observational data. In the last part the so-called nonthermal x rays and their production in the course of solar outbursts are considered. As an example, one particle flare is discussed quantitatively, also comparing x ray data with information obtained from radio observations. (auth)

36969 (ESRO-SP-6, Paper 13) OBSERVATIONS OF SOLAR X RAYS. Labeyrie, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 60p.

A comprehensive review of the measurements of x rays emitted by the quiet as well as the active sun is presented. Starting with the historic sounding rocket flight by Burnight in 1948 these observations were carried out by means of balloons, sounding rockets, and satellites, covering more than one solar cycle. The instruments used as well as the experimental results are discussed in detail. Some experimental and theoretical aspects of solar x-ray observations are considered in general, including absorption of x rays, production in the solar atmosphere, and correlation with geophysical phenomena. (auth)

36970 (ESRO-SP-6, Paper 15) OVERALL CONCEPT OF THE ESRO ASTRONOMICAL SATELLITE. Husain, L. A. (European Space Technology Centre, Delft (Netherlands)). 25p.

The most important scientific and technical specifications of the LAS are listed, including the scientific instrumentation specifications and the spacecraft design parameters. Possible technical solutions to the design problem of the LAS are reviewed. The conclusion is drawn that the design concept as proposed by ESTEC "presents an attractive line of development for the LAS and compares favorably with other overall concepts." (auth)

36971 (ESRO-SP-6, Paper 17) SOLAR XUV OBSERVATIONS FROM STABILISED SKYLARK ROCKETS. Wilson, R. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). 12p.

The attitude control unit developed for the Skylark sounding rocket is described: this unit points the whole rocket head at the sun with lateral errors of a few minutes of arc and roll error of a few degrees. A fine-guidance system was built at Culham Laboratory which, when mounted on the stabilized Skylark head, allows spectrograms and images to be taken with lateral deviations of not more than a few seconds of arc. The results of three rocket flights carried out in 1964 and 1965 are discussed. (auth)

36972 (LA-3729) MEASUREMENTS OF SOLAR X-RAY EMISSION FROM THE IONS CARBON VI AND NITROGEN VII. Evans, W. Doyle (Los Alamos Scientific Lab., N. Mex.). June 1, 1967. Contract W-7405-eng-36. 167p. Dep. CFSTI.

Thesis. Submitted to Univ. of New Mexico [Albuquerque].

Two identical instrument packages containing x-ray crystal spectrometers were flown aboard Nike-Tomahawk sounding rockets launched from Kauai, Hawaii, on August 8 and 11, 1967. Each package contained eight curved crystal, nonscanning spectrometers focused for selected wavelengths of the solar spectrum between 19 and 34 Å. During the high altitude portion of the flight the instrument axis was aligned toward the sun by an attitude control system. Four of the spectrometers used lead stearate soap film analyzers. Three were focused for the Lyman-α, -β, and -γ lines of C VI. The fourth was focused to obtain a measurement of the continuum intensity at 26.0 Å. Three spectrometers using KAP crystals were focused for the first three lines of the N VII Lyman series. The eighth spectrometer had the crystal replaced by a polished aluminum surface to test the sensitivity of the instruments to scattered ultraviolet light. Data were obtained from all stations on the first flight. On the second flight two of the KAP spectrometers failed, probably because of broken crystals. The count rates in all stations were essentially constant during the entire five minute period that the packages were above the atmosphere. On both flights excellent data on atmospheric absorption were obtained during the reentry portion of the flight. From the data of the first flight, intensities of 1.8 and 0.5×10^{-3} erg/cm^2-sec were determined for the N VII Lyman-α and -β lines respectively. The x-ray flux at 19.83 Å was interpreted as continuum radiation with an intensity of 5×10^{-3} erg/cm^2-sec-Å. The expected line structure for the C VI Lyman series was not observed. Because of an inconsistency in the absorption data it was suspected that the stearate stations were sensitive to x-ray wavelengths outside the expected instrumental resolution. Laboratory measurements were made of the specular reflection of long wavelength x rays from lead stearate crystals. For those spectrometers focused on the weaker lines and the continuum, specularly reflected x rays from the 40 to 120 Å region almost certainly introduced large errors. The measurement of the strong C VI Lyman-α line was less seriously affected. When a correction was made for the specular reflection the intensity of this line was found to be 2.9×10^{-3} erg/cm^2-sec on August 8 and 2.2×10^{-2} erg/cm^2 sec on August 11. The continuum intensity at 26.0 Å was 6×10^{-3} and 4×10^{-3} erg/cm^2-sec-Å on the two days. (auth)

36973 (N-67-18193) NONSINGULAR ORIGIN OF THE UNIVERSE. Harrison, E. R. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). [1965]. 9p. (NASA-TM-X-57251). CFSTI.

The theory that the universe originated from or passed through a space-time singularity of infinite density some 10^{10} years ago is examined. Because attempts to quantize the gravitational field encounter both formal and conceptual difficulties, qualitative arguments are adopted that show it is unlikely that the universe originated as a singularity. (STAR)

36974 (NP-16935) NEUTRON MONITOR OBSERVATIONS OF HIGH ENERGY SOLAR PARTICLES DURING THE NEW CYCLE. Baird, G. A.; Bell, G. G.; Duggal, S. P.; Pomerantz, M. A. (Bartol Research Foundation, Swarthmore, Pa.). [1967]. 23p. CFSTI.

After a lapse of five years, the first solar events in which particles were emitted with sufficiently high energies to produce intensity enhancements in ground-based neutron monitors occurred on July 7, 1966, and January 28, 1967. Although the magnitude of the first of these increases was too small (<2%) to permit detailed analysis, the later event, which exceeded 18% at sea level stations in the polar regions, displayed unusual characteristics. The January 28 event is anomalous in that either it represents the first observation of solar particles reaching the earth from the back side of the sun, or it is associated with a feeble flare (1-) in the unfavored eastern hemisphere of the visible disk. The propagation of solar particles in this event was evidently controlled by a diffusion mechanism, and the observations are consistent with predictions based on alternative theoretical models of this process. (auth)

36975 (SC-DC-67-1811) PROJECT TWINKLE. Gardner, R. E. (Sandia Corp., Albuquerque, N. Mex.). July 1967. Contract AT(29-1)-789. 19p. (CONF-671004-2). Dep. CFSTI.

For Presentation at Conference on Unguided Rocket Ballistics Meteorology, Las Cruces, N. Mex.

A series of upper atmosphere experiments was conducted by Sandia Laboratory, using Apache-Dart and Tomahawk-Dart rocket systems. The primary purpose of the experiments was to provide insight into the phenomenon of starlight scintillation. A discussion of the rocket development and experimental programs, with primary emphasis on the aerodynamic characteristics of the rocket and parachute systems, is presented. (auth)

36976 THE NEUTRON FLUX IN SPACE AFTER THE NOVEMBER 15, 1960, POLAR CAP NEUTRON EVENT. Chupp, E. L. (Univ. of New Hampshire, Durham); Hess, W. N.; Curry, C. J. Geophys. Res., 72: 3809-16(Aug. 1, 1967).

A neutron detector flown on an Atlas pod during the November 15, 1960, solar event measured a larger neutron flux than another detector flown on a similar vehicle during a quiet solar period. The excess neutron flux at low latitudes obtained by comparing these two measurements is higher than expected from the neutron production in the atmosphere by solar protons alone as deduced from Lingenfelter's calculations and Webber's model for the November 15 event. It is suggested that most of the discrepancy can be accounted for by considering neutron production by energetic solar alpha particles and lowered geomagnetic cutoffs. Gravitationally trapped neutrons and a refined model of atmospheric neutron leakage may account for the remainder of the apparent discrepancy. (auth)

36977 ^{3}He/(^{3}He + ^{4}He) RATIOS IN COSMIC RAYS, PATH LENGTHS IN SPACE, AND ENERGY SPECTRUM OF HELIUM NUCLEI IN LOCAL INTERSTELLAR SPACE. Biswas, S.; Ramadurai, S.; Sreenivasan, N. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 159: 1063-9(July 25, 1967).

Recent data on the ratios of ^{3}He/(^{3}He + ^{4}He) in cosmic rays in the energy interval 45-300 MeV/nucleon in 1963-65 have been used to determine the path length of helium nuclei in space. In these calculations the following were taken into account: (i) the energy dependence of the cross sections for the production of ^{3}He and ^{3}H from p + ^{4}He reactions and that of the total inelastic cross section as obtained from all available data, (ii) the ionization loss of ^{4}He and ^{3}He nuclei in space, and (iii) the solar modulation of the fluxes of ^{3}He and ^{4}He nuclei. It is shown that using the data of the measured ^{3}He/(^{3}He + ^{4}He) ratios, the accurately measured differential spectrum of He nuclei in the energy interval 30 to 1500 MeV/nucleon in 1965, and the Rβ (i.e., rigidity × velocity) dependence of the solar modulation, both the path lengths in space and the residual solar modulation, and hence the energy spectrum of the He nuclei in local interstellar space, can be determined, assuming a simple form of the source spectrum. The path lengths determined from ^{3}He/(^{3}He + ^{4}He) ratios are in agreement with those from Li/M ratios (M-nuclei: $6 \leq Z \leq 9$). The path length of multiply charged nuclei in space is found to have a maximum value of about 7 to 9 g cm^{-2} of hydrogen at 200 to 300 MeV/nucleon and to drop to about 2 to 3 g cm^{-2} at 50 MeV/nucleon and to 3.5 g cm^{-2} at 1000 MeV/nucleon. The source spectrum is found to be consistent with a power spectrum in rigidity, but not with a power spectrum of total energy per nucleon or power spectrum of kinetic energy per nucleon with an exponent of 2.5. (auth)

36978 CHANGES IN THE INTENSITY OF THE 5303 A AND 6374 A CORONAL LINES IN THE COURSE OF THE LAST TWO SOLAR CYCLES (1944-1964). Gentili Di Giuseppe, M.; Hugon, M.; Leroy, J. L.; Rosch, J.; Trellis, M. (Observatoire du Pic-du-Midi, France). Ann. Astrophys., 29: 43-7(Feb. 1966). (In French).

From observations made at the Pic-du-Midi Observatory, comparisons were examined in the variations of the coronal line intensities (5303 and 6374 Å) during the last two solar cycles (1954 to 1964 and 1944 to 1954). No large difference in the behavior of the 5303 Å line could be found. For 6374 Å line the intensity variations were slightly different, especially near the minimum of solar activity. The results are compared with those derived from observations made at the Climax and Sacramento Peak observatories. (BBB)

36979 RADIAL PULSATIONS OF AN INFINITE CYLINDER IN THE PRESENCE OF HELICAL CURRENTS. Hans, Harikrishan (Univ. of Delhi). Proc. Nat. Inst., Sci. India, Pt. A, 32: 251-5(May 1966).

The radial pulsations of an infinite cylinder of uniform density and infinite electric conductivity in the presence of helical currents are studied for the case when $\xi = \delta_r/r_0$ is a function of the displacement from the axis of the cylinder. It is found that the frequencies of pulsations are of the same order both when ξ is a function of displacement and when ξ is constant in space. (auth)

36980 HEAVY-ION REACTIONS IN STARS. Duorah, H. L. (Univ. of Gauhati, India). Indian J. Pure Appl. Phys., 5: 76-9 (Mar. 1967).

The heavy-ion reactions such as C + C, C + O, and O + O in stellar interiors at temperatures $T \gtrsim 6 \times 10^8$ °K and density of $\rho = 10^4$ g/cm^3 are analyzed in terms of optical model data reported in literature. At the lower temperature range, these reactions are found to be faster than the photodisintegration rate of ^{20}Ne and, as such, these reactions may be the sources of α particles at the low temperature range considered. The calculated rates of reaction have been found to be slower than the calculated values reported earlier. It is concluded that the reaction rates cannot be calculated with sufficient accuracy at present so that a determination of the abundances of certain elements in the relevant region of mass numbers can be made. (auth)

36981 MEASUREMENTS OF COSMIC RADIO EMISSION IN THE KILOMETER-WAVE RANGE IN INTERPLANETARY SPACE. Slysh, V. I. Kosm. Issled. Akad. Nauk SSSR, 4: 923-31 (Nov.-Dec. 1966). (In Russian).

Data concerning the intensity of low-frequency emission in interplanetary space in the 20 to 2200-kc range were obtained from measurements made by the Zond-2, Zond-3, and Venera-2 interplanetary stations. Data obtained by the Zond-2 show that the radio emission on the 210-kc frequency is approximately 3×10^{-18} w/m^2 kc, a value approximately 100 times greater than the expected radio emission stream from the galaxy on this frequency. The Zond-3, launched on 18 July 1965, in the direction of the orbit of Mars, was equipped with a three-channel measuring receiver with channel frequencies of 20, 210, and 2000 kc. A dipole formed by the housing of the station and 3.75-m metallic rod antenna was used in both the Zond-2 and Zond-3 stations. The Venera-2 was also equipped with a three-channel measuring receiver which operated on frequencies of 30, 200, and 985 kc. Its antenna was similar to those used on Zond-type stations. These experiments established that radio emission intensities on frequencies of 985, 2000, and 2200 kc are in good agreement with galactic noise data obtained by other authors. In the 210 to 20-kc range the spectrum increases sharply toward lower end frequencies. The change in intensity with distance, the observation of interference lobes, and possibly, screening by the Moon indicate Jupiter as an emission source at a frequency of 200 kc. Screening by the Moon occurs during differential refraction in the upper ionosphere. Radio emission in the 20 to 30-kc frequency range can be explained by the fluctuation noise of interplanetary electrons. Agreement between Jupiter's radio emission spectra on kilometer and decameter waves was also noted. Data indicate that Jupiter is a source of very powerful low-frequency radio emissions. If the spectrum ranges up to 100 kc, the total power of the low-frequency emission is approximately 10^{20} erg/sec. This value is 1000 times greater than Jupiter's decimeter wave emission and constitutes 10^{-5} of the planet's total thermal emission. (ATD)

36982 PERSISTENCE OF SOLAR FLARE REGIONS RELATED TO THE PRODUCTION OF ENERGETIC PROTONS AND INTERPLANETARY MAGNETIC FIELDS. Sakurai, Kunitomo (Kyoto Univ.). Pub. Astron. Soc. Japan, 18: 350-6 (1966).

The distribution of the sites on the solar surface of solar flares accompanying solar cosmic-ray production are examined for the declining phase of solar activity, and the interrelation between the Sun's and interplanetary magnetic fields are considered. Only two regions (designated A and B) have been noted on the solar surface where solar flares producing solar cosmic rays have frequently occurred during the declining phase of solar activity (1959 to 1963). They were separated by about 160° in heliographic longitude from each other. They were identified with magnetically active regions on the Sun. The large-scale structure of the magnetic fields near the sun and in interplanetary space was deduced using measurements of the interplanetary magnetic field and the heliographic longitude dependence of the solar wind velocity obtained by the satellite IMP-1. The region in which the solar proton flows were observed is located in the western portion of the positive sector extended from the region A on the Sun. (BBB)

36983 A STUDY OF PLANETARY NEBULA NGC 1514. II. SPECTROSCOPIC INVESTIGATION OF THE CENTRAL STAR. Koboutek, L.; Hekela, J. (Astronomical Inst., Prague. Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech., 18: 203-8 (1967).

Spectral analysis of the central star of the planetary nebula NGC 1514 within the interval λλ 3650 to 5000 Å confirmed the existence of the ultraviolet excess, explainable by the radiation contribution of a smaller but much hotter star (X component) to the radiation of the primary one (A component). The absolute magnitude of the A component, obtained from the Hγ equivalent width, is $M_{V,A} = -1.4$; its spectral type is A0 III (II). The value of the atmosphere electron density, $\log N_e = 15.2$, which is two times lower in comparison with the main sequence A0 star, confirms the higher luminosity class for the planetary central star. The obtained value of interstellar absorption, $A_V = 1.97$, is in full agreement with results of photoelectric measurements, based on the assumption that the ratio of the total to the selective absorption is R = 3.2. (auth)

36984 DIMENSIONS OF SOUTHERN PLANETARY NEBULAE. Westerlund, Bengt E. (Australian National Univ., Canberra); Henize, Karl G. Astrophys. J., 14: Suppl., 154-74 (Apr. 1967).

Direct photographs in Hα light with the Mount Stromlo 74-inch reflector were obtained of 229 objects listed by Henize as planetary nebulae or possible planetary nebulae. Of these, 151 are found to be resolved. The morphological classifications, surface brightnesses, and angular dimensions of these nebulae are tabulated, and photographs of 99 nebulae are given in an atlas accompanying the catalog. (auth)

36985 IMPORTANCE OF THE PHOTO-BETA PROCESS FOR THE SYNTHESIS OF "p" ELEMENTS IN STELLAR CONDITIONS. Arnould, M. (Univ. Libre, Brussels). Nucl. Phys., A100: 657-72 (1967).

The positron capture and photo-beta disintegration probabilities in several stellar conditions are compared. It is shown that the second process can be neglected with regard to the first one in strongly endothermic nuclear transitions, whereas photo-beta disintegration can be competitive with positron capture and even can have a greater likelihood than the latter process in weakly endothermic and exothermic transitions. In the range of temperature considered ($T \approx 10^9$ °K), it appears that the lifetime ratio $\tau(\text{ph})/\tau(e^+_c)$ against photo-beta disintegration and positron capture is the smallest for densities in the neighborhood of 10^6 g/cm^3. Thus, the conclusion is reached that the photo-beta process can play a role in the synthesis of two "p" elements at least, $^{144}_{62}$Sm and $^{196}_{80}$Hg, for which the ratios $\tau(\text{ph})/\tau(e^+_c)$ are close to 10 and 20, respectively, in the most favorable stellar conditions. (auth)

36986 PULSATION THEORY. Christy, R. F. (California Inst. of Tech., Pasadena). Annu. Rev. Astron. Astrophys., 4: 353-92 (1966).

This review (with 70 references) considers the question of stellar pulsation in what is referred to as the Cepheid instability strip in the H–R diagram or in the log g –log T_e diagram. This strip includes the classical δ Cepheid variables, Population-II Cepheids, and RR Lyrae variables, as well as the RV Tauri variables, δ Scuti variables, and dwarf Cepheids, which appear to belong in this same general class. The basic equations of the instability theory for spherically symmetric motion are written in a Lagrangian coordinate system. Calculations are then based on treatment of a static model derived from these equations, supplemented with tables or formulas for the opacity and expressions for nuclear energy generation. As the result of the static model calculation, a description is obtained of the pressure, temperature, and density as a function of position in the star. This description is then the basis for the linear theory of small-amplitude oscillations around the static model; it also serves as the initial state for large-amplitude nonlinear calculations. Causes of instability, including that from nuclear energy generation, are discussed, as well as periods of variable and binary stars. The instability problem is also considered. In addition to a discussion of the determination of the period of a pulsating variable and conclusions about the location of the instability strip and about the luminosity and mass, various new conclusions now emerging from these calculations are examined. (BBB)

36987 STRUCTURE OF RADIO GALAXIES. Moffet, Alan T. (California Inst. of Tech., Pasadena). Annu. Rev. Astron. Astrophys., 4: 145-70 (1966).

It is now generally assumed that synchrotron radiation from energetic electrons is responsible for the continuum emission in discrete radio sources, and that this mechanism accounts for virtually all nonthermal radio emission from celestial objects. On the assumption that the emission from radio galaxies is synchrotron radiation, the requisite energies in relativistic particles and magnetic fields can be estimated once the luminosities and dimensions are known. However, this review, with 109 references, reveals that the theory of radio galaxies is in a rudimentary state. The dynamics of an expanding plasmon must somehow be reconciled with the observations, in particular with the observation that many of the strongest radio galaxies have radio luminosities in the range 10^{44} to 10^{45} erg/sec, though their source regions range in size from more than 100 kpc down to a few kpc, or even down to a few parsecs if the quasi-stellar sources are included. Yet adiabatic expansion by a factor of 10 in size calls for a drop in luminosity by a factor of about 10^3. The tight containment of sources such as 3C 33 or other objects which may have even greater ratios of separation to dia. such as 3C 343, must be explained. A more firmly based concept of the nature of the intergalactic medium would aid in the calculation of plasmon dynamics.

The question of the origin and energy source of radio galaxies is completely open at present; it may be associated with the problems posed by the quasi-stellar radio sources. (BBB)

36988 ON AN EXACT SOLUTION OF EINSTEIN'S GRAVITATIONAL EQUATIONS AND ITS APPLICATIONS TO THE GROUPS OF GALAXIES AND TO THE QUASI-STELLAR RADIO SOURCES. St. Kalitzin, Nikola (Komplex Lenin, Sofia). Wiss. Z. Friedrich-Schiller-Univ., Jena, Math.-Naturwiss. Reihe, 15: 81-2 (1966).

An exact solution is given of Einstein's gravitational equations for the problem of insular spherically symmetric accumulation of matter in empty space. The model investigated considers a spherical region G in which there is a spherically symmetric distribution of matter. Inside the region of G it is assumed that the pressure is zero and that the density depends only on the time, while outside the density of matter vanishes and the field is asymptotic in Euclidean (or Minkowskian) space at infinity. According to the assumption that the density ($\rho = \epsilon/c^2$) in the region G depends only on the time, it follows that in a system of coordinates, which at each point moves with the matter at this point (the so-called comoving coordinates), the well-known particular solution of Einstein's gravitational equations in G is obtained. According to the assumption used, the density of matter vanishes outside the region G; therefore, the field outside G must be given by Schwarzschild's exterior solution. The expression derived was applied to multiple galaxies and clusters of galaxies and then to quasars. For a radius of a quasar $r = 2R_g = 6 \times 10^{13}$ cm and mass $M = 10^8 M_\odot$, from this formula it follows that the peripheral velocity takes the value of 211,000 km/sec, i.e., the velocity of an extraordinary cosmic explosion. Such a velocity of matter cannot be the result of either nuclear reactions or of the pressure of gases or of light. This is a pure relativistic effect and justifies the hypothesis that the pressure of gases and of light can be neglected in this problem. A slight asymmetry in the expansion of this insular accumulation of matter can cause an ejection of great quantities of matter out of the quasar, thus explaining the fact that there are usually 2 distinct radio sources in the quasars. At the anticollapse, protons and electrons are ejected in considerable quantities, which moving in the expanding magnetic field of the quasar produce synchrotron radiation. For $r = 2 \times 10^{16}$ cm, the derived formula gives for the peripheral velocity 11,540 km/sec. The analysis of the spectral lines of quasars shows that the quasars expand with a velocity from 800 to 6900 km/sec. It is suggested that the solution of Einstein's gravitational equations for the expanding insular accumulation of matter explains the expansion of such apparently unconnected objects as the groups of galaxies and the quasars. (BBB)

36989 INFLUENCE OF 2ND-ORDER SCATTERING UPON THE DISTRIBUTION OF LIGHT IN REFLECTION NEBULAE. Svatos, J. (Charles Univ., Prague). Bull. Astron. Inst. Czech., 18: 201-3(1967).

It is shown that the function ϕ_n, introduced by Irvine, can also be applied to approximative expressions for the distribution of light in reflection nebulae. Using these functions, the influence of second order isotropic and anisotropic scattering upon this distribution of light is estimated. The possible influence of second order scattering upon the measured intensity increase in the nebula NGC 7023 is discussed. (auth)

36990 PHOTOELECTRIC PHOTOMETRY OF BL ANDROMEDAE. Vetesnik, M. (Purkyne Univ., Brno). Bull. Astron. Inst. Czech., 18: 208-14(1967).

The light curve based on 261 photoelectric observations in blue color was determined for the system BL Andromedae. The period is discussed and the solution of the elements is given. The system is very close and analogous to the eclipsing binary KR Cygni. (auth)

36991 SPHERICALLY SYMMETRIC PROBLEMS IN GENERAL RELATIVITY. Pachner, J. (Astronomical Inst., Prague). Bull. Astron. Inst. Czech., 18: 219-28(1967).

A system of equations for spherically symmetric problems in general relativity is deduced in its most general and physically clearest form. The equations, without the cosmological term, are integrated in particular special cases and thoroughly discussed with regard to the occurrence of physical singularities. An analytical proof is given that there exists no static spherically symmetric closed world model wholly filled with matter exhibiting a positive pressure. Further, it is shown that the pressure gradient eliminates the occurrence of singularities outside the center of symmetry during a collapse as well as in cosmology. The pressure gradient cannot stop the contraction of a spherically symmetric closed world model and convert it to a new expansion before all matter of the world has contracted to a single point. (auth)

36992 RADIAL MOTIONS IN SMALL AND YOUNG SUNSPOTS. Bumba, V. (Astronomical Inst., Ondrejov, Czech. Kitt Peak National Observatory, Tucson, Ariz.). Bull. Astron. Inst. Czech., 18: 238-43(1967).

Radial velocities for about 40 small and young sunspots and dark areas in two sunspot groups and some facular fields were measured on spectrograms obtained with the world's largest solar telescope. The absence of the normal Evershed effect in the spots studied was established. Instead of upward motions normally observable in the penumbras of regular spots no motions or downward motions in these small spots without penumbra were found as in umbras of regular spots. These motions are smaller in photospheric lines (from about 0.5 to 6 km/sec) and greater in Na $D_{1,2}$ lines (10 to 14 km/sec). The results obtained seem to agree with the assumption that the physical processes causing the cooling of a young sunspot are diametrically different from those taking place in regular spots and that the dynamics in such very young sunspots is more closely related to the dynamics of integranular space. (auth)

36993 FIELD REVERSAL MAGNETOHYDRODYNAMIC DYNAMO MODEL OF ASTROPHYSICAL INTEREST. Csada, I. K. (Konkoly Observatory, Budapest). Bull. Astron. Inst. Czech., 18: 243-8(1967).

A continuation is given of an investigation of the magnetohydrodynamic dynamo problems. The velocity field applied to the driving mechanism is practically the same as used previously. By introducing a vector field in addition to the internal one, the boundary conditions are satisfied for a stronger external field than that found for the atmospheric field in the earlier paper. It seems that the present model will be more convenient for the field reversal theory of magnetic variables. It is shown that the velocity field does not decay due to the effect of the Lorentz force in the present model. (auth)

36994 X-EMISSION OF EXPANDING FLARES. Valnicek, B. (Astronomical Inst., Czechoslovak Academy of Sciences, Ondrejov). Bull. Astron. Inst. Czech., 18: 249-51(1967).

From the flare of March 20, 1966, it was found that the period of maximum x-ray emission burst and the burst in the cm range agree with the moment at which maximum velocity of expansion of both parts of the flare is reached. In the given case, intensive radio flashes also appear on all wavelengths. At the same time the radiation maximum appeared in the optical region. (W.D.M.)

36995 DYNAMIC SPECTRA OF SOLAR RADIO BURSTS IN THE CONTINUOUS FREQUENCY RANGE 50 TO 210 Mc/s. Tlamicha, A. (Astronomical Inst., Czechoslovak Academy of Sciences, Ondrejov). Bull. Astron. Inst. Czech., 18: 251(1967).

A block diagram is given for a new radio spectrograph in the range 50 to 210 Mc. Dynamic spectra recorded on Feb. 21 and 23, 1967, are presented, including types III, V, and I of solar radio bursts. (W.D.M.)

36996 CALIBRATION OF MEASUREMENTS MADE WITH A MAGNETOGRAPH. Rachkovskii, D. N. Izv. Krym. Astrofis. Observ., 36: 51-5(1967). (In Russian).

Results are given of computed calibration curves of measurements made with a magnetograph. In the calculations the following were taken into account: (a) only true line absorption, (b) only line scattering, and (c) thin-layer line formation. It is shown that if an identical profile of the absorption coefficient is assumed, the allowance for only scattering or only true absorption does not influence the calibration curves. It is also shown that allowance for the equipment performance has little influence on the transverse field signal but significantly changes that of the longitudinal field. The calibration curves computed on the assumptions of a thin and an optically thick layer differ significantly in the case of a transverse field signal and practically coincide in the case of a longitudinal field signal. (auth)

36997 CALIBRATION OF THE RECORDS OF A SOLAR MAGNETOGRAPH. Severnyi, A. B. (Abastumani Astrophysical Observatory, Tbilisi, USSR). Izv. Krym. Astrofiz. Observ., 36: 22-50(1967). (In Russian).

Calibration of the signals of longitudinal $\delta_{||}$ and transverse $\delta_{\perp}$ magnetic fields recorded by a solar magnetograph was carried out by three different methods. All three methods lead to calibration dependences which are in good mutual agreement but deviating very strongly (by 200 to 300%) from theoretical dependence obtained for optically thick spectral lines in a homogeneous field. Analysis of all possible sources of this divergence has led to the conclusion that existing theories are inadequate because they do not account for the real observed inhomogeneity of the magnetic field. The use of new calibration curves leads to the field inside umbra of a sunspot which is more longitudinal and 2 to 3 times

stronger as compared with former conclusions based on magnetograph measurements, but this is in agreement with direct measurements. (auth)

36998 TEMPORAL VARIATIONS OF THE MAGNETIC FIELD IN ACTIVE SOLAR REGIONS. Gopasyuk, S. I. Izv. Krym. Astrofiz. Observ., 36: 56-68(1967). (In Russian).

Photoelectric observations of longitudinal magnetic fields in two active regions were studied. For one of the active regions the observations cover the whole process of spot development, and for the other only the disappearance stage. Radial velocities obtained at the stage of appearance of the spot were also used. (auth)

36999 INVESTIGATION OF MOTIONS IN FLARES RELATIVE TO THE TRANSVERSAL MAGNETIC FIELD COMPONENT. Ogir, M. B. Izv. Krym. Astrofiz. Observ., 36: 69-75(1967). (In Russian).

The character of motions in four chromospheric flares relative to the transverse magnetic field is considered. Motions directed toward a weak field region and also toward a strong field region were observed. In the first case the velocities are relatively small, equalling 20 km/sec on the average. In the second case they are much larger, attaining 100 km/sec. The observed motions are directed mainly along the vectors of the transverse field or close to them. The motion of the front ceases when it reaches a field region of opposite orientation, it then moves in a backward direction. The four flares considered appeared in the form of two or more knots located in regions of opposite polarity and brightened almost simultaneously. At least one of the knots was located in the direct vicinity of a neutral line of the longitudinal field. (auth)

37000 SIMULTANEOUS REGISTRATION OF THE MAIN PARAMETERS OF A MAGNETIC FIELD BY MEANS OF A MAGNETOGRAPH. Nikulin, N. S. Izv. Krym. Astrofiz. Observ., 36: 76-86(1967). (In Russian).

A new electronic device for a magnetograph is described. It provides for simultaneous recording of the longitudinal component and the vector components of the transverse magnetic field. A new analogous computing device is introduced in the design and permits the registering of the magnitude and azimuth of the transverse field. (auth)

37001 A DETERMINATION OF THE SOLAR ABUNDANCE OF SEVERAL ELEMENTS FROM SUNSPOT SPECTRA. IV. THE LITHIUM ABUNDANCE (6707.9 A). Dubov, E. E. Izv. Krym. Astrofiz. Observ., 36: 87-9(1967). (In Russian).

The equivalent width of the Li resonance line 6707.9 Å and those of several lines of Na and Al, measured in spot spectra, were used for determining the Li abundance by means of the curve of growth. It is found that $\lg N_{Li} = 1.2 \pm 0.3$. This value differs from that obtained from the Li line 6103.6 Å ($\lg N_{Li} = 1.8$) and only slightly exceeds the Li abundance in the photosphere $\lg N_{Li} = 0.96$. The latter difference is within the limits of possible errors. It is adopted that $\lg N_{Li} = 12.0$. Apparently the formation of the 6103.6 Å line comes not only from the absorption of lithium atoms, but other factors as well. (auth)

37002 ON THE DETERMINATION OF THE Li LINE 6103.64 A IN SUNSPOT SPECTRA. Prokof'ev, V. K.; Severnyi, A. B. Izv. Krym. Astrofiz. Observ., 36: 90-7(1967). (In Russian).

The possibilities of detection of the first doublet (6103.6 Å) of the diffuse series Li(I) ($2^2P^0_{3/2,1/2} - 3^2D_{5/2,3/2}$) in spot spectra at conditions of complex blending are discussed critically. For four spots with magnetic fields of 2700 to 3400 gauss the equivalent width of the doublet is estimated on the basis of laboratory wavelengths as not exceeding 1 mÅ. The problem on the wavelengths of the lines of this doublet in the solar spectrum remains open. (auth)

37003 MECHANISM OF ORIGIN OF DECAMETER EMISSION DURING THE FLARE OF JULY 12, 1961. Krivskii, L.; Neshpor, Yu. I. Izv. Krym. Astrofiz. Observ., 36: 98-102(1967). (In Russian).

The development of a solar flare is compared with radioemission in the decameter range. It is shown that the formation of visible systems of loop-like prominences occurs after the propagation of a plasma cloud through heights at which they are located. An appreciable increase in radioemission in the decameter range is observed at the time of appearance of loop-like prominences. (auth)

37004 PRELIMINARY RESULTS OF OBSERVATIONS OF MICROBURSTS OF SOLAR EMISSION AT 10.2 CM. Yurovskii, Yu. F. Izv. Krym. Astrofiz. Observ., 36: 103-11(1967). (In Russian).

Additional parts which increase the stability of the reference noise generator of the 10-cm radiometer and the method of calibration of the latter by means of lunar radioemission are described. On the basis of a preliminary reduction of recordings of solar radioemission obtained with this radiometer, it is concluded that condensations with a short lifetime, responsible for "gradual increase and decrease of intensity" type bursts, are formed before the appearance of the optical flare and are of longer duration. The difference in time between the two appearances is inversely proportional to the intensity of the phenomenon. (auth)

37005 SOME PECULIARITIES OF TYPE-II BURSTS ACCOMPANIED BY TYPE-IV BURSTS. Eliseev, G. F.; Yurovskaya, L. I. Izv. Krym. Astrofiz. Observ., 36: 112-20(1967). (In Russian).

It is shown that in cases when type-II bursts are accompanied by type-IV bursts in the meter range, the difference in time Δt between the commencements of a type-II burst and a burst in the centimeter range is greater, on the average, the closer the flare is to the eastern limb of the solar disk, i.e., the Δt distribution indicates east–west asymmetry. In cases when type-II bursts are not accompanied by type-IV bursts, Δt does not depend on the coordinates of the flare. The possibilities of explaining the east–west asymmetry are discussed with two assumptions: (1) the condensations are inclined to the west, and (2) the agent, responsible for type-II bursts, deviates to the east from the radial direction when moving through the corona. It is shown that the second supposition is more probable. (auth)

37006 RADIO EMISSION OF BEHIND-THE-LIMB FLARES. Eryushev, N. N. Izv. Krym. Astrofiz. Observ., 36: 121-5(1967). (In Russian).

The following preliminary conclusions are made from a study of the radioemission of six behind-the-limb flares. (1) For various flares the lower limits of heights above the photosphere of radioemission generation are: 16,500 ± 3,500 and 21,000 ± 7,000 km at the 3-cm wavelength and 26,000 ± 5,000, 31,000 ± 7,000, and 55,000 ± 10,000 km at the 10-cm wavelength. (2) The heights of localization of radioemission sources increase with the intensity of the flare. (auth)

37007 SOLAR RADIO EMISSION BURSTS AT 8 MM. Moiseev, I. G.; Efanov, V. A. Izv. Krym. Astrofiz. Observ., 37: 128-36(1967). (In Russian).

It is shown that the three main types of solar radio bursts, characteristic of the centimeter range, are also observed at 8 mm: impulse bursts of type-A, the postburst slow intensity decrease to the preburst level of type-B, and the slow intensity increase and decrease of type-C. The sources of impulse bursts at 3 cm, and probably at 8 mm, are characterized by directivity of emission, which is evidenced in an increase on the average of burst intensities observed on the earth with increasing distance of the sources from the central meridian. The detected anisotropy of radiation can be explained if it is assumed that the bursts are of synchrotron origin and are generated in solar regions with a predominantly radial magnetic field component. (auth)

37008 DISTRIBUTION OF CENTERS OF ACTIVITY WITH HELIOGRAPHIC LONGITUDE. Levitskii, L. S. Izv. Krym. Astrofiz. Observ., 37: 137-45(1967). (In Russian).

The association between regions with radio noise storms at meter wavelengths and proton flares and type-IV bursts during the period July 1957 to December 1963 is discussed. It is shown that in the majority of cases proton regions and regions in which type-IV bursts occurred are accompanied by a prolonged radiation increase at meter wavelengths of the noise-storm-type (if the area of the spot group is not too small). At the same time type-IV bursts were observed only in about 30% of all the regions connected with noise storms and about 20 to 25% in regions connected with proton flares. The distribution with heliographic longitude (relative to the Carrington meridian) of the following phenomena is discussed: proton flares, flares accompanied by type-IV bursts, chromospheric flares (importance 2 and higher), regions with noise storms and spot groups with an area $S \geq 500$ millionth parts of the hemisphere (m.p.s.). It is shown that flares with importance lower than 3, noise storms of low intensity and spot groups with $S < 1000$ m.p.s. are distributed uniformly with heliographic longitude. However, all the notable phenomena—proton flares, flares generated by type-IV bursts, flares with high importance (3 and 3^+), strong noise storms, and large area spot groups ($S \geq 1000$ m.p.s.)—show a sharply expressed concentration in the 300 to 0 to 140° longitude interval as compared to 140 to 300° interval. During all of the period studied this nonuniformity in distribution is very stable, as though regions with intensified activity did not participate in the differential rotation of the sun and had a synodic rotational period of 27.3 days. (auth)

37009 POSITIONS OF NOISE STORM SOURCES RELATIVE TO OPTICAL FEATURES ON THE SOLAR DISK. Yurovskaya, L. I. Izv. Krym. Astrofiz. Observ., 37: 146-52(1967). (In Russian).

The deviation angles of noise storm sources relative to radial directions through the center of an active region or flare are computed. It is shown that noise storm sources deviate very slightly to the east. No significant difference was detected in the deviations for proton and nonproton regions. On the average the sources deviate to the west if the flare is accompanied by type-IV bursts, in the opposite case to the east. (auth)

37010 IONOSPHERIC DISTURBANCES FROM REGIONS WITH PROTON AND NONPROTON FLARES. Eliseeva, L. A. Izv. Krym. Astrofiz. Observ., 37: 153-7(1967). (In Russian).

It is found that regions in which proton flares originate are characterized by higher activity as regards SID, due to x radiation of solar flares. In particular, ionospheric effects connected with flares in these regions occur 7 times more frequently, on the average, than those associated with regions with nonproton flares. (auth)

37011 VARIATIONS OF THE RELATIVE NUMBER OF PROTON FLARES OF DIFFERENT IMPORTANCE DURING A SOLAR ACTIVITY CYCLE. Levitskii, L. S. Izv. Krym. Astrofiz. Observ., 37: 158-61(1967). (In Russian).

The variations of the relative number of proton flares of different importance for each year during the period July 1957 to December 1963 are discussed. It is shown that the fraction of proton flares of importance 3 and 3^+ relative to all the flares of such importance does not vary on the average during the whole cycle of solar activity, while the per cent of proton flares of importance 1 and 2 increases toward the minimum of solar activity. The ratios of proton flares, accompanied by type-IV bursts, to all the type-IV bursts, behave in a similar manner. (auth)

37012 INFLUENCE OF THE TERRESTRIAL ATMOSPHERE ON THE RECEPTION OF SOLAR RADIO EMISSION AT 10 CM. Yurovskii, Yu. F. Izv. Krym. Astrofiz. Observ., 37: 162-70 (1967). (In Russian).

On the basis of a study of recordings of the flux density of solar radioemission it is found that: (a) atmospheric oxygen and water vapor absorption measured by the transparence method is in agreement with the results obtained previously by other methods, (b) appreciable fluctuations are observed in the flux density, depending on the altitude of the source above the horizon, (c) the variations in the observed flux at average cloudiness do not exceed 0.5%, and (d) during strong rainfall the fluctuations in the flux density attain 2%. It is concluded that the terrestrial atmosphere and hydrometeors only slightly effect the registration of microbursts of solar radioemission if the height of the sun above the horizon exceeds 15° and the clouds are not rain clouds. (auth)

37013 AN ANALYSIS OF SPECTRA OF HIGH-GALACTIC-LATITUDE O STARS. Kumaigorodskaya, R. N. Izv. Krym. Astrofiz. Observ., 37: 182-90(1967). (In Russian).

The spectra of two high-galactic-latitude O stars, HD 93521 and HD 60848, are studied. The measured W_λ and also various parameters of the atmospheres of these stars are compared with similar characteristics of O stars of the flat subsystem. It follows that the atmospheres of high-galactic-latitude O stars do not differ appreciably from those of O stars of the flat subsystem. A difference is found only in parameters which are connected with the peculiarities of these stars. The intensified neutral helium lines observed in the spectrum of HD 93251 are explained by the existence of large microturbulent motions in the atmosphere of this star. A somewhat higher helium abundance as compared to hydrogen is noted in the atmospheres of high galactic latitude stars as compared to O stars of the flat subsystem and nuclei of planetary nebulae. The absolute magnitudes, spectral types and rotational velocities of the investigated stars are derived. On the basis of determinations of absolute magnitudes of high-galactic-latitude stars and additional considerations on the luminosity of HD 93251 star it is doubtful that this star was formerly the nucleus of a planetary nebula. (auth)

37014 A STUDY OF SUPERGIANT ATMOSPHERES. I. A QUANTITATIVE ANALYSIS OF η LEO. Zeinalov, S. K. Izv. Krym. Astrofiz. Observ., 37: 191-204(1967). (In Russian).

The physical conditions and chemical composition of the A0 Ib supergiant η Leo were analyzed by the curve of growth method and the half-width and equivalent line width correlation. Four spectrograms with an average dispersion of 1.3 A/mm obtained at the Coudé focus of the 2.6 m reflector during 1964 were used. The existence of a dependence between the excitation temperature, ionization, and mean temperature of the stellar atmosphere (T_{ex}, T_{ion} and $\bar{T}$) and the excitation potential is confirmed. The microturbulent velocity v_t decreases with depth from 10.8 km/sec to 6 km/sec and the macroturbulent velocity increases from 4 km/sec to 7 to 8 km/sec in the interval $\bar{\tau}_{eff}$ from 0.14 to 1.0. The sound velocity C_β (β) increases with depth in this same interval from 11.9 to 16.6 km/sec and is always larger than of small eddies. A comparison of the relative abundance of elements in the η Leo atmosphere with that of standard stars did not reveal any anomalies. (auth)

37015 AN INVESTIGATION OF PHYSICAL CONDITIONS IN THE ATMOSPHERES OF EARLY-TYPE CLOSE BINARIES. II. AO CAS. Galkina, T. S. Izv. Krym. Astrofiz. Observ., 37: 205-35(1967). (In Russian).

The spectrum of the close binary AO Cas is analyzed on the basis of 105 spectrograms obtained with a dispersion of 37 A/mm in the region $\lambda\lambda$ 4950 to 3600 A during November 1963 to February 1964 and August 1964 to February 1965. The radial velocities of the components $K_1 = \mp 220$ km/sec and $K_2 = \mp 160$ km/sec are determined from measurements of the differential line shifts in the spectra of the primary and secondary components relative to the H and Ca(II) interstellar calcium lines. The measurements of absorption lines show that the spectral type of the primary varies with phase from 09.1 to 08.0. The spectral type of the secondary component is estimated as 07.2. The brightness difference between the components $\Delta m = 0^m32$ as derived from relative intensities the He(I) and He(II) lines and 0^m65 from the H(I) lines. The absolute magnitudes of the components determined from the hydrogen lines are $M_{vI} = -5^m3$ and $M_{vI} = -4^m7$. According to its physical characteristics the AO Cas binary system is located at the lower boundary of the MS of O and B stars in the H–R diagram. The equivalent absorption line widths in the spectra of both components show considerable variations at elongation. (auth)

37016 A STUDY OF A BINARY SYSTEM WITH AN ENVELOPE AX MON. Boyarchuk, A. A.; Pronik, I. I. Izv. Krym. Astrofiz. Observ., 37: 236-43(1967). (In Russian).

The characteristics of the binary AX Mon were studied on the basis of 38 spectrograms obtained with dispersion from 13 to 33 Å/mm during 1959 to 1966. It is shown that the system consists of a hot B1 IV-type star and a cold KO III-type star, which are surrounded by an asymmetric envelope. The envelope is forming as a result of outflow of matter from the surface of the hot component with a velocity about 10 km/sec. The peculiarities in the absorption line intensity ratios are explained by a hydrogen deficiency in its atmosphere. (auth)

37017 A SPECTROSCOPIC STUDY OF V 568 CYG AND o HER. Rachkovskaya, T. M. Izv. Krym. Astrofiz. Observ., 37: 244-50(1967). (In Russian).

The spectra of two Ia type stars, V568 Cyg and o Her, are compared to those of normal stars of the same spectral type using spectrograms obtained with dispersion 15 Å/mm. The compariseon did not reveal any appreciable differences between the spectra of the compared stars. (auth)

37018 POLARIZATION OBSERVATIONS OF SEVERAL VARIABLE STARS. Efimov, Yu. S. Izv. Krym. Astrofiz. Observ., 37: 251-61(1967). (In Russian).

Results are given of polarization observations of variable stars of different types. Appreciable polarization variations are detected for RW Tri, AB Aur, and RW Aur. A correlation between polarization and B–V variations is found in the case of RW Aur. (auth)

37019 ON THE EXPLANATION OF THE ANOMALOUS REDDENING EFFECT OF HOT STARS IN CLUSTERS AND O ASSOCIATIONS. Raznik, R. M. Izv. Krym. Astrofiz. Observ., 37: 262-6 (1967). (In Russian).

The detected excess reddening of O–B3 type stars in clusters and O associations as compared to the reddening of stars of later spectral types can be explained by the presence of stars with an envelope (Be) with large anomalous reddening among the B stars. The presence of stars with envelopes is one of the reasons for the large dispersion in the two-color diagrams for open clusters and O associations. The assignment of normal color indices of nonemission stars to stars with envelopes can lead to errors in the determination of distances to B0 stars amounting to 40%. (auth)

37020 DETERMINATION OF OSCILLATOR STRENGTHS OF Fe II FROM THE SPECTRUM OF PROCYON. Bogudlov, A. M. Izv. Krym. Astrofiz. Observ., 37: 267-72(1967). (In Russian).

Absolute oscillator strengths were determined for 35 Fe(II) lines by the curve of growth method, using a spectrum of Procyon (α CMi) obtained with a dispersion of 1.1 to 2.2 Å/mm. An attempt is made to estimate the precision of the applied method. The main errors are due to errors in the determination of the equivalent line widths and errors in the already known oscillator strengths of Fe(II) lines. (auth)

37021 INVESTIGATION OF METALLIC EMISSION LINES IN MOUSTACHES ON THE DISK. Koval, A. N. Izv. Krym. Astrofiz. Observ., 37: 62-81(1967). (In Russian).

Metallic line emission in moustaches has the following peculiarities: (a) Lines with high Rowland intensities, formed at rather great heights in the solar atmosphere have extended two-sided moustaches. (b) Many of these lines show blue asymmetry, which is the more pronounced the weaker the line. The asymmetry is very pronounced at the initial stage of development of moustaches and later decreases. (c) Lines with lower Rowland intensities, which form in lower depths of the solar atmosphere have a one-sided short blue moustache. (d) Anomalous Na (D_1, D_2) and Mg (b_1, b_2, b_3) line emission is observed. Photometric emission profiles of moustaches in metallic and hydrogen lines are obtained and the broadening mechanism investigated. A Doppler emission distribution in moustaches is in good agreement with observations. The $\Delta\lambda_D/\lambda$ ratio and the derived "turbulent" velocities are different for hydrogen and the metals and indicate a velocity increase with height. The character of line emission in moustaches apparently indicates that the moustache phenomenon is somewhat stratified with height. (auth)

37022 A DETERMINATION OF THE ABUNDANCE OF SEVERAL ELEMENTS IN THE SUN USING THE SUNSPOT SPECTRA. V. THE GALLIUM ABUNDANCE. Khromova, T. P. Izv. Krym. Astrofiz. Observ., 37: 89-93(1967). (In Russian).

The λ4172.05 A line is used in order to determine the gallium abundance in the sun. It is found that $\lg N_{Ga} = 1.44 \pm 0.4$ from sunspot spectra and $\lg N_{Ga} = 2.16 \pm 0.4$ from spectra of the photosphere. It is shown that this difference can be explained by the presence of a blend at the Ga 4172.05 A line. The allowance for the presence of a blend leads to an identical value of the gallium abundance $\lg N_{Ga} = 1.43 \pm 0.40$ (at $\lg N_H = 12.0$) as obtained from spectra of sunspots and the photosphere. (auth)

37023 ON SOME PECULIARITIES OF THE ORIGIN AND MOTION OF FLARES ACCOMPANIED BY TYPE-IV BURSTS. Ogir, M. B. Izv. Krym. Astrofiz. Observ., 37: 94-104(1967). (In Russian).

Data obtained by means of recordings of flares on film with the coronograph of the Crimean Astrophysical Observatory are used for the investigation. General characteristics of flares accompanied by type-IV bursts are described on the basis of a study of 24 flares: (a) flares accompanied by type-IV bursts originate in the form of two practically parallel bright ribbons, which are very close to each other at the initial phase of the flare, the distance between them increasing with time; (b) the region occupied by both parts of the flare at the initial moment of time is very narrow (by about one order less than that of flares having a similar form at the initial phase but not accompanied by type-IV bursts); (c) a strong activization of neighboring filaments and the appearance of strong surges are observed; and (d) these bursts are characterized by rapid motions of the emission front of at least one of the flare ribbons. The association between the appearance of a flare and magnetic field variations before its origination is confirmed. This relation is evidenced in an increase in size in the penumbras of spots and decrease in the distance between them and also in the appearance of new spots of opposite polarity near existing spots. An association is found between the mean velocity of motion of the flare ribbon, which has a larger velocity, and the magnetic field gradient in the region of the neutral point and also the type-IV burst intensity. The existence of a relation between the magnetic field gradient and the type-IV burst intensity at 3 cm is also noted. (auth)

37024 SIMILARITY RELATIONS IN MAGNETOHYDRODYNAMICS AND THE POSSIBILITY OF SIMULATING SOME SOLAR PHENOMENA IN THE LABORATORY. Dubov, E. E. Izv. Krym. Astrofiz. Observ., 37: 105-8(1967). (In Russian).

In an attempt to simulate solar magnetohydrodynamic processes in the laboratory the extremely large-scale differences of the phenomena must be taken into account. The similarity relations developed in the theory of gaseous discharges cannot however be used for this purpose. New similarity relations must be obtained on the basis of equation systems, which include the system of state and equations of motion. For various quantities measured in the laboratory under a definite scale ratio the necessary correspondence has been inferred. Great difficulties are met in simulating solar phenomena in a laboratory and, in any case, powerful impulse technique is necessary. (auth)

37025 RADIO AND HARD X-RAY RADIATION OF SOLAR FLARES. Gopasyuk, S. I.; Eryushev, N. N.; Neshpor, Yu. I. Izv. Krym. Astrofiz. Observ., 37: 109-17(1967). (In Russian).

Synchrotron and decelerating radiation of energetic electrons is considered at the assumption that the magnetic field of the generating region contracts with time. It is found that magnetodecelerating losses of relativistic electrons with time increase proportionally to the third power of contraction. The general character of temporal variations of magnetodecelerating losses is in agreement with the development rate of the premaximum stage of centimeter radio bursts. Decelerating losses of nonrelativistic electrons ($E_0 = 2 \cdot 10^5$ ev) also rather strongly depend on the contraction of the region and increase as the square root of the third power of contraction. (auth)

37026 TEMPORAL VARIATIONS OF THE X-RAY RADIATION OF THE SOLAR FLARES OF AUGUST 7, 1960. Neshpor, Yu. I. Izv. Krym. Astrofiz. Observ., 37: 118-20(1967). (In Russian).

The temporal variations of the x radiation of the solar flare of August 7, 1960, were computed using the radio astronomical method of absorption measurement and also discrete measurements of x radiation obtained by means of a Sputnik. The mean value of the effective recombination coefficient for the ionospheric D region is determined. (auth)

37027 AN INVESTIGATION OF THE MAGNETIC FIELD AND GAS VELOCITY IN SUNSPOTS AT DIFFERENT LEVELS, WITH THE MAGNETOGRAPH. I. AN INVESTIGATION OF THE EVERSHED EFFECT IN A COMPLEX SPOT GROUP. Ikhsanov, R. N. Izv. Krym. Astrofiz. Observ., 37: 44-55(1967). (In Russian).

The Evershed velocities in the large complex group of spots observed in September 1963 were studied. Three lines of different intensity were used for the determination of the radial velocities, thus permitting the investigation of motions of matter in the spots at various depths. It was found that the Evershed velocity varies with depth; the velocity gradient with depth depending on the size of the umbra (spot) as well as the value of the Evershed effect. The relation between the maximal radial velocity u_m and the position of the umbra (spot) on the solar disk also indicates that there is a velocity gradient with depth in a spot. This relation differs for velocities u_m, determined from lines of various intensities: a lower line intensity corresponds to a steeper decrease of u_m with approach to the limb. (auth)

37028 SOLAR WIND AND THE SHOCK WAVE PROPAGATING FROM FLARES THROUGH INTERPLANETARY SPACE. Dvoryashin, A. S. Izv. Krym. Astrofiz. Observ., 36: 126-33 (1967). (In Russian).

The spiral structure of the interplanetary magnetic field, resulting from continuous radial expansion of the solar corona in interplanetary space, is confirmed by an investigation of temporal regularities in absorption phenomena in the polar cap due to high-energy particles from proton flares. On the basis of a sufficiently large number of cases it is found that the velocity of propagation of the agent, responsible for the sudden commencement (SC) of magnetic storms, through interplanetary space is higher by a factor of 2 to 4 than that of the solar wind. It is concluded that the SC of magnetic storms is due to the passage of the Earth through a collisionless shock front. The width of the front computed for a collisionless shock wave at small Mach numbers coincides in one case with that of the front measured directly in interplanetary space. The structure of the interplanetary magnetic field, deformed by the propagation of a shock wave from the sun, is discussed. (auth)

37029 PHYSICAL CHARACTERISTICS OF HOT STARS. Kopylov, I. M. Izv. Krym. Astrofiz. Observ., 36: 134-54(1967). (In Russian).

The values of $\lg n_e$ and $\lg P_e$ for the atmospheres of 316 early type stars (predominantly O5–F2) are computed on the basis of previous papers. The mean values of $\lg n_e$ and $\lg P_e$ for stars of different spectral sequences (luminosity classes) are determined. The results are compared with computed theoretical models of stellar atmospheres. The dimensions of homogeneous hydrogen atmospheres ($\lg H$) and radii ($\lg R$) of hot stars are computed. The ratio $\lg H/R$ varies monotonically with spectral type from −1.0 for O5 stars to −5.0 for A7 stars, and then increases to −3.0 for G-type stars. The relative dimensions of supergiant atmospheres ($\lg H/R$) are about the same as those of MS stars of corresponding temperatures. In all cases in theoretical analyses the atmospheres of stars can be considered as plane-parallel layers. The dependence of mass and gravity acceleration at the surface on spectral class for the main spectral sequences (luminosity classes V, IV, III, Ib, and Ia) are obtained from an analysis of the evolutionary tracks of stars with 1 to 63 $M_\odot$ in the ($\lg L/L_\odot$, $\lg T_{eff}$) diagram. The values of $\lg H$ for O4.5 to F0.3 stars of different luminosity classes are determined on the basis of theoretical models of stellar atmospheres. (auth)

37030 THE VELOCITY FIELD IN THE ATMOSPHERE OF THE SUPERGIANT η LEO (A0 Ib). Zeinalov, S. K.; Kopylov, I. M. Izv Krym. Astrofiz. Observ., 36: 155-74(1967). (In Russian).

A spectrophotometric analysis of the velocity field in the atmosphere of the supergiant η Leo was carried out using spectrograms with a dispersion of 1.3 A/mm, obtained with echelle spectrograph in the Coudé focus of the 2.6-m telescope. The microturbulent velocities v'_{tm} for several homogeneous groups of lines are found by the curve of growth method. The microturbulent v_{tm} and macroturbulent v_M velocities for these same groups of lines are determined by the method proposed previously by Huang and Struve and improved by van den Heuvel. Several conclusions on the character of the velocity field variations with height in the stellar atmosphere are made from a comparison of v'_{tm}, v_{tm}, and v_M: the velocity of macroturbulent or (convective) motions decreases with height and the velocity of microturbulent motions increases. (auth)

37031 A STUDY OF THE PHYSICAL CONDITIONS IN THE ATMOSPHERES OF EARLY-TYPE CLOSE BINARY SYSTEMS. I. PLASKETT'S STAR HD 47129. Galkina, T. S. Izv. Krym. Astrofiz. Observ., 36: 175-201(1967). (In Russian).

The spectrum of the spectral binary HD 47129 (O7f + O) is analyzed using spectrograms with a dispersion of 37 Å/mm in region $\lambda\lambda 4950 - H_{1\beta}$. The spectral-type variations of the principal component with phase are found from absorption lines in its spectrum. The spectrum varies from O6.5 to O8.0. The difference in the γ velocity of the components $\gamma_2 = \gamma_1 - 25$ km/sec is derived on the basis of radial velocity curves. The latter are obtained from measurements of the differential displacement of lines relative to the H and K lines in the spectra of the principal and secondary components. The absorption line intensities in the spectra of both components are analyzed. It is found that the absorption line intensities of the secondary component vary appreciably with phase and wavelength. The He(I), He(II), and H relative line intensities of both components are used for determining the difference in spectral type $\Delta Sp = 0.8$ and luminosity $\Delta m = 0.7$ of the components. The behavior of He(II) $\lambda 4686$ and N(III) $\lambda\lambda 4641$ to 4634 line emission and also the H_δ and H_γ line profiles at different phases is studied. (auth)

37032 A SPECTROPHOTOMETRIC STUDY OF ζ TAU. Boyarchuk, A. A.; Pronik, I. I. Izv. Krym. Astrofiz. Observ., 36: 203-9(1967). (In Russian).

The hydrogen line profiles, the equivalent widths of sharp metallic absorption lines, the curves of growth, and turbulent velocities were found on the basis of 23 high-dispersion spectrograms. The correlation between turbulent velocity and the ratio of shortwave-to-longwave emission components of hydrogen lines is confirmed. It is shown that at the end of 1965 the mass of the envelope was smaller than that of 1964 by a factor of 2. (auth)

37033 SPECTROPHOTOMETRIC OBSERVATIONS OF AB AUR DURING 1963 AND 1964. Rachkovskaya, T. M. Izv. Krym. Astrofiz. Observ., 36: 210-15(1967). (In Russian).

Results are given of a study of 29 spectra, obtained during 1963–1964 with a dispersion of 36 Å/mm in the $\lambda\lambda 3700$ to 5000 Å region, and several spectrograms of the H_α line. Irregular temporal variations of the hydrogen emission line intensities and also the equivalent widths of hydrogen absorption lines are detected. A comparison of the spectrum of AB Aur with those of normal stars of the same spectral type does not indicate an appreciable difference. The position of AB Aur on the H–R diagram is determined. (auth)

37034 PHOTOMETRIC AND COLORIMETRIC CHARACTERISTICS OF ERUPTIVE STARS. III. THEORETICAL LIGHT CURVES OF A RADIATIVE GAS WITH ALLOWANCE FOR IRREVERSIBLE RECOMBINATIONS, EXPANSION AND COOLING EFFECTS. Gershberg, R. E. Izv. Krym. Astrofiz. Observ., 36: 216-39(1967). (In Russian).

In order to obtain a more precise nebular model of the flares of UV-Cet-type stars, theoretical light curves of optically thin gaseous bodies were computed taking into account irreversible recombinations, expansion, and cooling effects. The relation between the luminosity of these bodies and electron temperature was considered and general expressions were found for calculating the theoretical light curve on the assumption of any given law of electron temperature variations. The theoretical light curves were then computed for two cases: (1) adiabatic cooling of the gas, assuming expansion of different dimensions (one, two, and three) and various ratios of the characteristic expansion time to the characteristic recombination time (A/B = 0 to 10), and (2) pure radiative cooling at different initial temperatures of the radiative gaseous bodies (T_0 = 10,000 to 50,000°K). Monotonous adiabatic cooling of the gas leads to less steep light curves and a less pronounced dependence of these curves on the geometry of expansion. However at $A/B \geq 1$ the adiabatic effect is insignificant. In the case of pure radiative cooling the temperature of the gas decreases very rapidly from T_0 to about 12,000°K and then decreases slowly to 5000 to 6000°K. As the cross sections of free–bound and free–free transitions increase with electron decreasing temperature, the luminosity of the gas can increase during the initial rapid cooling, and calculations show that maximum brightness can occur somewhat later than the moment of appearance of the hot gas above the photospheric level. The ratios of the rate of brightness increase before maximum to that of brightness decrease after maximum obtained from theoretical curves is close to the corresponding ratios for observed EV Lac flares. In the case of simultaneous adiabatic cooling and radiative losses the theoretical light curves form a three parameter family of curves, which is described by the system of equations (32). Numerical solutions of (32) are obtained for 75 combinations of different values of the three parameters above. It is shown that the majority of observed light curves of flares of UV-Cet-type stars can be represented by this family of theoretical curves. The influence of collision ionization on the degree of ionization of radiative hydrogen is discussed in Appendix I. The radiative losses on H^- ions are computed in Appendix II. It is shown that both effects are negligible in calculations of radiation and cooling of the gaseous formation which may be expected during UV-Cet-star flares. More precise photometric parameters of optically thin gas formations necessary for computations of a nebular model of flare stars are given in Appendix III. Computations which permit the estimation of the total mass of ionized gas in a flare from the total radiation of the flare in the photographic region, on the assumption of a nebular model, are given in Appendix IV. (auth)

37035 ON THE EVOLUTION OF CLASSICAL CEPHEIDS. Efremov, Yu. N.; Kopylov, I. M. (Abastumani Astrophysical Observatory, Tbilisi, USSR). Izv. Krym. Astrofiz. Observ., 36: 240-59(1967). (In Russian).

UBV photometry of 11 open clusters and associations, which have 19 Cepheids altogether, are re-reduced. The values of M_V, $(B-V)_0$ and M_{bol} of the Cepheids are determined. The ages of the clusters t_{cl}, t_l and τ_l are found using the brightest members of the MS of the clusters and also theoretical evolutionary tracks. Adopting the hypothesis that the stars evolve horizontally after leaving the MS, the lifetime t_0 of present-day Cepheids on the MS as B stars is computed. The time interval $T_0 = t_l - t_0$, which has elapsed since the Cepheid left the MS, is determined from these data. The dispersion of the period of the Cepheid age of cluster dependence and data on Cepheids in NGC 1866 permit the estimation of the maximal duration of the Cepheid state T_C (for P from 3 to 10 days) as included within the limits of about 3 and $1 \cdot 10^7$ years. The time T_C should be identified by the interval between the first entrance into and final exit of the star from the band of instability. The star spends only a small fraction of this time (i.e., the time $t_C \approx 1$ to 5×10^6 years) in the band of instability. A comparison of the relative number of B stars and Cepheids and the times t_0 determines the time t_C and not T_C. Therefore the supposition that only a small fraction of B stars with corresponding masses can evolve to Cepheids should be rejected. The character of the evolutionary tracks also provides for a wholly satisfactory explanation of the results obtained by Arp for NGC 1866 and the decrease in the number of Cepheids with decreasing period for P < 5 days. Results permit the conclusion that Cepheids are a repeating stage of development of massive stars. In this stage they spend only 10 to 20% of their whole lifetime as late supergiants. (auth)

37036 THE SPACE DISTRIBUTION OF EARLY B AND A0 STARS IN THE DIRECTION OF GALACTIC LONGITUDES 117 TO 124°. Grigor'eva, N. B. Izv. Krym. Astrofiz. Observ., 36: 260-3(1967). (In Russian).

The space density of B0–B2 and A0 stars is determined in an area of about 45° square degrees centered at $\alpha = 0^h30^m$, $\delta = +62°$. The stars were selected from the catalog of spectral types and color indices. The space densities were computed according to the method proposed by Schalen, using stellar magnitudes corrected for interstellar absorption. The mean absolute magnitude $M_V = -4.00$ was adopted for the B stars and $M_V = +0.2$ for the A0 stars. In both cases the dispersion of absolute magnitudes was as high as $\delta = 0^m5$ and the steps in magnitude $\delta = 0^m5$. Accordingly it was found that $M_V = -4.2$ for the B stars and $M_V = 0.0$ for the A0 stars. The results of computations of the space density of stars are given. The curve for the A0 stars indicates that the density increases at a distance of ~400 ps and then decreases continuously with increasing distance from the Sun. Evidently this local fluctuation of density corresponds to the Orion arm: according to radio data the distance to the arms in this direction is 400 pC. The shape of the curve for the B stars confirms an earlier conclusion on the density increase of these stars in the distance interval 1.5 to 3 kps, the maximum corresponding to 2 kps. McCuskey obtained similar results for a neighboring region centered at $\alpha = 1^h40^m$, $\delta = +60°$. (auth)

37037 QUANTITATIVE ESTIMATES OF THE ANOMALOUS REDDENING OF EARLY TYPE STARS IN YOUNG OPEN CLUSTERS AND O ASSOCIATIONS. Raznik, R. M. Izv. Krym. Astrofiz. Observ., 36: 264-73(1967). (In Russian).

The anomalous reddening effect of early-type stars was estimated quantitatively, using 31 open clusters and 7 O associations. The color excesses are computed for 557 stars. The dependence of E_{U-B} on spectral-type Sp is investigated for stars of each cluster and association. The anomalous reddening ΔE_{U-B} is determined for each spectral subclass relative to the mean reddening E_{U-B} found from stars later than B3. The mean values $\Delta E'_{U-B}$ are derived on the basis of all stars of the studied clusters and O associations. The dependence of $\Delta E'_{U-B}$ on spectral type is also discussed. More precise values are found for the maximum of anomalous reddening which is attained at B0: $\Delta E'_{U-B} = 0^m.14 \pm 0^m.052$ for open clusters and $\Delta E'_{U-B} = 0^m.25 \pm 0^m.0.24$ for O associations. It is confirmed that the anomalous reddening observed for high luminosity stars is also sharply defined for MS stars. Precise spectral classification of stars enables the detection of the anomalous reddening effect. (auth)

37038 MAGNETIC FIELDS OF SMALL SUNSPOTS AND PORES. Steshenko, N. V. Izv. Krym. Astrofiz. Observ., 37: 21-8(1967). (In Russian).

Spectrograms of 20 pores with diameters from 1.5 to 6″ obtained at conditions of high quality solar images (resolution higher than 1″) were used for measurements of the magnetic fields of pores. The spectrograms were taken at the Mount Wilson Observatory during 1965. It was found that the magnetic field strength of the smallest pores (1.5 to 2″) was 1400 gauss on the average and that of the larger pores ≥1500 gauss. Not one of the observed pores had a field strength less than 1000 gauss. Spectrograms obtained at the Crimean Astrophysical Observatory during days with good quality solar images show that the field strength of small sunspots with diameters within the limits 6 to 12″ is greater by 200 to 300 gauss than the mean field strength of the smallest pores. On the other hand visual observations of magnetic fields indicate the presence of field strengths up to 1000 gauss, and sometimes higher, in places without spots. On the basis of these data it is concluded that the minimal field strength in spots or pores is about 1000 to 1200 gauss. The magnetic field of a pore is an extremely compact formation. The field gradient along the solar surface at the umbra photosphere boundary is ≥4 gs/km for pores with a diameter of ~5″. It is noted that the fine structure of the magnetic field of small spots and pores can play an essential role in the development of many active processes on the Sun. A rare case of observation within a great spot of a very small element (diameter not greater than 2″) with a field strength of 5350 gauss is described. (auth)

37039 VELOCITY FIELD IN AN ACTIVE REGION AT SPOT APPEARANCE STAGE. Gopasyuk, S. I. Izv. Krym. Astrofiz. Observ., 37: 29-43(1967). (In Russian).

Radial velocities in a bipolar region were studied. The velocities were measured by means of a magnetograph alternatively in the λ5250 Å and H_β lines during the whole process of spot development. It is shown that the velocity field in an active region at the spot appearance stage differs essentially from that of developed spot groups. At chromospheric level a considerably larger fraction of the gas in the active region descended. The descent velocity of the gas was largest in the magnetic field region of the appearing spot. The ratio of the flow of the descending gas to the flow of the ascending gas is 10 in all of the active region (at equal densities). This value is close to that observed for an active region at the termination of a flare of importance 3^+. At photospheric level the gas in almost all of the magnetic field region ($H_{||} > 17$ G) of the appearing spot also descended. The region of maximal velocity of gas descent was near the spot. The distance between the position of maximal velocity of gas inflow in the developing spot and the center of its magnetic field increased systematically at the photospheric and also chromospheric levels. The maximal velocities of the gas descending into the spot also varied. In weak magnetic field regions the velocities often changed sign. At different levels of the solar atmosphere the ratio of the flow of the descending gas to the flow the ascending gas in the region of fields with $H_{||} < 17$ G varied with time in opposite phase, and in the region of fields with $H_{||} > 17$ G—in phase. This ratio decreased with time for an appearing spot in the region of fields with $H_{||} > 17$ G while it increased for an already existing spot in field regions with $H_{||} > 17$ G. As the spots developed the gas flow ratio of the active region in the chromosphere and also the photosphere approached the value characteristic of developed groups. (auth)

37040 NUCLEAR TRANSFORMATION IN NATURE. Vlasov, N. A. At. Energ. (USSR), 22: 339-42(May 1967). (In Russian).

The problem of the limits of the stability of nuclei relative to the emission of protons and neutrons as well as the conditions for the existence in nature of neutron-excess nuclei near the stability limits was considered. The possibility of explaining some anomalies in the emission of elements and isotopes assuming the collision of existing cosmic bodies with antimatter is shown. The existence of antimatter in the Galaxy can lead to the formation of radioactive spots on the moon's surface. (tr-auth)

37041 THE LARGE TWO-MIRROR RADIOTELESCOPE OF THE NANCAY STATION. STUDY OF THE POINTING EQUIPMENT. Ginat, M.; Steinberg, J. L. (Observatoire de Paris, Meudon, France). Rev. Phys. Appl., Suppl. J. Phys., 2: 79-96 (June 1967). (In French).

The plane tilting mirror of the Nancay radiotelescope consists of ten independent panels, which are servoed to remain parallel. After a short review of the structure of the panels, a description is given of the inclination measuring system which is a Ferranti digitizer driven by the main shaft of the panels through a device correcting for differential rotation between reflector surface and shaft, the calibration of the four Ferranti digitizers controlling the "master" mirrors, and the servo-systems which control the six remaining "slave" mirrors. (auth)

37042 OBSERVATIONS OF SOUTHERN PLANETARY NEBULAE. Henize, Karl G. (Northwestern Univ., Evanston, Ill.). Astrophys. J., 14: Suppl., 125-53(Apr. 1967).

An Hα survey of the entire southern sky south of −25° declination with the Mount Wilson 10-inch objective-prism camera resulted in a catalogue of 459 objects classifiable as planetary nebulae or possible planetary nebulae. Of these, approximately 150 are newly discovered. The catalog gives for both old and new nebulae basic data including intensity of the Hα image, intensity of the continuum, degree of resolution of the Hα image, and presence of emission lines other than Hα. Where possible, nebular diameter and the intensity ratio of [N II] λ6584 to Hα are also listed. Since one of the more significant features of this catalog is its broad coverage and its observational uniformity, a careful study of its purity and completeness has been made. The surface distribution of these nebulae shows, in addition to the well-known concentration toward the galactic center, significant concentrations in Norma and Crux. An analysis of the frequency of [N II] shows that 22% of the nebulae which might show [N II] have [N II]/Hα ratios greater than 0.5, 22% have ratios between 0.1 and 0.5, and 56% show no [N II]. (auth)

37043 QUASARS: RAPID LIGHT FLUCTUATIONS. McCrea, W. H. (Univ. of Sussex, Eng.). Science, 157: 400-2(July 28, 1967).

Surprising new discoveries about light fluctuations in a particular quasar may be interpreted as occultation effects. With this clue, the published observations are used to infer as much as possible about the structure of the quasar. If the resulting model is valid, it shows that a quasar may be regarded at an early stage in the formation of a system like the nucleus of a galaxy; at any instant, the optical radiation would come from one or a few temporary stars situated among a very large number of protostars, the occultations being caused by some of these. (W.D.M.)

37044 INFRARED STARS. Johnson, Harold L. (Univ. of Arizona, Tucson). Science, 157: 635-8(Aug. 11, 1967).

Searches for very cool stars have revealed three kinds of objects: very cool Mira stars, perhaps cooler than any of this type previously known; extremely dense interstellar clouds, more dense than any known heretofore; and, probably, cool circumstellar clouds that may be planetary systems in an early stage of formation. The work on infrared stars has shown that the dark nebulas of the Milky Way are indeed extremely opaque. Not only do the dark nebulas of the Milky Way obstruct the view of the distant stars but we have reason to believe that, given propitious circumstances, they can be the spawning places for stars. In an early stage of their development, young stars are imbedded in the interstellar matter from which they were born and are surrounded by "left-over" circumstellar clouds which in time will become planetary systems. If the interpretations are correct, a large percentage of solar-type stars have planetary systems. (auth)

37045 EXPERIMENT TO CHECK A HYPOTHESIS ON THE ANTIMATTER NATURE OF METEOR SHOWERS. DATA PROCESSING. Belyaevskii, A. I. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 37: 756-73(Apr. 1967). (In Russian).

The first section deals with the choice of criteria for checking the statistical significance of the difference of random parameters $\bar{x}_1$ and $\bar{x}_2$ for two sets distributed according to the Poisson law. It is shown that if it can be established by statistical analysis or by any other method that the random parameters indeed belong to such sets, then t-criteria based on the Student distribution are not to be used in constructing statistically significant criteria with an

approximation of the Poisson law by the normal distribution. A nonparametric criterion of homogeneity and methods of analyzing the correlation of two series of observations are discussed. The second section discusses such data processing methods as the "coherent summation method" (superposition of events, which is considered the basic method) and other control methods such as coherent summation in the interval between two events, and exclusion of overlapping events. The above methods were used in processing data to check a hypothesis on the antimatter nature of meteor showers. (ATD)

37046 THERMAL BOUNDARY LAYER OF THE SOLAR CONVECTION ZONE. Boehm, Karl-Heinz; Stueckl, Eva (Univ., Heidelberg). Z. Astrophys., 66: 487-95(1967). (In German).

The formation of a thermal boundary layer near the bottom of the outer solar convection was studied within the framework of the mixing length theory. It is assumed that in general the mixing length is equal to the pressure scale height, but that it cannot become larger than the distance to the nearest boundary of the convection zone. The main result of this calculation shows that, in a layer of about 30,000 km thickness above the lower boundary, there appears a considerable increase in the difference between the actual and the adiabatic gradients (as compared to the usual type of calculation). Although the change of the mean temperature and pressure stratification is very small, the results do strongly influence the basic data for any hydrodynamic computation of the convective flow (e.g. in the study of overshooting). (auth)

37047 CALCULATION OF ATMOSPHERE MODELS BY MEANS OF DISCRETE OPTICAL DEPTH. Scholz, Michael T.; Traving, Gerhard (Hamburger Sternwarte, Hamburg). Z. Astrophys., 66: 475-86(1967). (In German).

The linearity of the Φ and Λ operators was used to obtain solutions of the radiative equilibrium problem by means of operations in (K + 1)-dimensional spaces, where K + 1 is the number of given discrete optical depths. The gray and the picket-fence model require only the solution of a system of linear equations. An extension to more general nongray cases is possible. (auth)

37048 Hγ AND He I LINES IN O9-B5 SPECTRA. Deeming, T. J. (Univ. of Texas, Austin); Walker, G. A. H. Z. Astrophys. 66: 457-74(1967).

Measurements of the equivalent widths of the He I lines at λ4388 and λ4471 and measurements of Hγ equivalent widths in low-dispersion spectra (50 to 60 A/mm) of 425 O 9 to B 5 stars are analysed. The mean equivalent width of Hγ and the mean He I half width increase towards later spectral types, while the He I equivalent widths show a broad maximum around B 3. The variation of the mean of the ratio $W_{HE\,I}/W_{H\gamma}$ with spectral type agrees fairly well with theoretical predictions for both He I lines based on the assumption that both lines are subject to linear Stark broadening. The scatter in the ratio is large and this may mean a large range of atmospheric He I abundances in these stars. When individual spectral types are considered there is a correlation between the half widths of the He I lines and their equivalent widths which increases towards later spectral types but there is little or no correlation of the half widths with the equivalent width of Hγ. It is suggested that some of the sharp lined B3e stars must be slow rotators since they are too frequent amongst B3e stars as a whole to be consistent with a uniformly high rotational velocity a random distribution of rotational axes. The correlation between the He I half widths and equivalent widths, and the distribution of points in the plots of half widths against equivalent widths are interpreted as implying a variation of atmospheric helium abundance with rotational velocity. In some respects this is qualitatively compatible with the mechanism of diffusive separation of helium from the atmospheres of slowly rotating B stars suggested by Greenstein, Truran, and Cameron. If this interpretation is correct, there is no longer a discrepancy between observed helium abundances and the predicted formation of primordial helium in the hot early stages of the universe, or the results of the theory of stellar structure and evolution. (auth)

37049 IMBEDDING OF A MODEL UNIVERSE WITH MAGNETIC FIELD IN A PSEUDO-EUCLIDIAN SPACE. Smaranda, D. (Faculty of Mathematics and Mechanics, Bucharest). Bull. Soc. Roy. Sci. Liege, 36: 103-10(1967). (In French).

The semi-closed magnetic model of universe, which has the metric $ds^2 = dt^2 - X^2(t)\,dr^2 - Y^2(t)\,[d\theta^2 + \sin^2\theta d\varphi^2]$ is considered, and the necessary and sufficient condition of being of class one is set. The imbedding formula is found simultaneously. (auth)

37050 C_2 BALLIK-RAMSAY BANDS IN LATE CARBON STARS. Hunaerts, J. (Royal Observatory of Belgium, Uccle, Belg.). Astrophys. J., 149: L31-2(July 1967).

McCammon, Münch, and Neugebauer (1967) reported that the most remarkable feature in the spectra of the late N-type stars Y CBn and U Hyd is the sharp discontinuity or band head at 1.76 μ. It is suggested that this absorption be attributed to the $\Delta v = 0$ sequence of the C_2-Ballik-Ramsay system $A'^3\Sigma_g^- - X'^3\Pi_u$, which is one of the few known examples of an electronic transition in the infrared region of the spectrum. (W.D.M.)

37051 PROFILE OF THE UNIDENTIFIED INTERSTELLAR ABSORPTION BAND AT 6180 A AT DIFFERENT GALACTIC LONGITUDES. Seddon, H. (Royal Observatory, Edinburgh). Nature (London), 215: 495-6(July 29, 1967).

The interstellar absorption band at 6180 A was first observed by Wilson (Publ. Roy. Obs. Edin., 2:3 (1956)), who speculated as to an interstellar origin. Profile determination is difficult because of the weakness and width of this and similar bands, but may be crucial in the determination of their origin. The band is not appreciably affected by stellar or atmospheric line absorption. In an earlier communication (Nature, 214: 257 (1967)), relating to 4430 Å, a double Gaussian profile was assumed and fitted; the same profile is found to fit 6180 Å well, with the further assumption that $\Delta\lambda/\lambda$ is equal for any two equivalent points on the two profiles, where $\Delta\lambda$ is the wavelength difference of a point from the center of the profile λ_0. (UK)

37052 AN UPPER LIMIT TO CIRCULARLY POLARISED RADIATION FROM THE CRAB NEBULA. Andrew, B. H. (National Research Council, Ottawa); Purton, C. R.; Terzian, Y. Nature (London), 215: 493-4(July 29, 1967).

A small intense source of low-frequency radio emission has been detected in the Crab Nebula. Neither the thermal nor the synchrotron emission mechanisms can satisfactorily account for its characteristics, and a plasma mechanism, possibly similar to that of a solar flare, has been proposed. It has been stated that radiation from a plasma mechanism would probably be strongly circularly or elliptically polarized. This communication reports a search for such polarized radiation from the Nebula at 40 Mc, using the 1,000-ft.-diameter radio telescope of the Arecibo Ionospheric Laboratory. At this frequency the compact source accounts for ~20% of the integrated radiation from the Nebula. A description is given of the receiving system employed, and its manner of operation. Data corresponded to $2.0 \pm 2.5\%$ right circular polarization. The absence of significant circular polarization does not rule out a plasma mechanism, but indicates that if such a mechanism is responsible for the emission, then the magnetic field in the source does not play an important part in the process. (UK)

37053 MAGNETIC FIELD ANNIHILATION IN CURRENT PINCHES. Piddington, J. H. (CSIRO, Sydney). Planet. Space Sci., 15: 733-40(Apr. 1967).

Magnetic field annihilation in current pinches (or neutral sheets) is important in many astrophysical situations and in the laboratory. The observational data are not explained by simple magnetic diffusion theory and none of the numerous modifications has been generally accepted. Here the discrepancy is attributed to the unjustified use of a coefficient of electrical conductivity based on ohmic losses alone. An idealized (infinite plane) pinch sheet is described, in which the diffusion velocity is determined by ohmic losses alone; but the field lines also move parallel to the isobars with a velocity which may be many orders of magnitude greater, and a powerful polarization field is developed. This precarious balance is upset by two factors which may be present in the solar corona and geomagnetic tail and may cause "flares." First, the magnetic field lines traversing the pinch region connect to a region of high Pedersen conductivity in the lower chromosphere or ionosphere and tend to short-circuit the pinch. Second, inertial forces due to gas acceleration are present as well as the pressure gradient, and the drift of electrons and field lines is deflected from the isobars and into the neutral sheet. A geomagnetic tail model gives enhanced reconnection and annihilation by factors up to 10^6 and reveals a curious asymmetry about the midnight meridian. Another boundary effect which might occur in the solar corona could cause explosive reconnection rates. (auth) (UK)

37054 CONVECTIVE INSTABILITY OF AN INHOMOGENEOUS GASEOUS MASS. Tassoul, Jean-Louis (Univ. of Chicago). Ann. Astrophys., 30: 363-70(May-June 1967). (In French).

The adiabatic pulsations of an inhomogeneous gaseous mass consisting, under certain circumstances, of a convective core and a radiative envelope were investigated. In that particular case, a variational method is used to show the existence of four spectra among which two correspond to gravity modes. The model, as a whole, is unstable when the criterion for convective stability is locally violated; however, unstable oscillations remain principally confined to the convective core. (auth)

37055 EFFECT OF GRAINS ON JEANS' INSTABILITY CRITERION. Kalra, G. L.; Talwar, S. P. (Univ. of Delhi). Ann. Astrophys., 30: 371-5(May-June 1967).

The problem of stability of a static, infinite, gravitating medium consisting of a homogeneous mixture of gas and grains is investigated. It is found that the Jeans' critical wavelength of instability is unaffected by the collision frequency of grains with the gas but is lowered with the increasing density and the decreasing temperature of grains. (auth)

37056 THE ELECTRON TEMPERATURE OF H II REGIONS. Sofia, Sabatino (Goddard Space Flight Center, New York. Yale Univ. Observatory, New Haven). Ann. Astrophys., 30: 377-82(May-June 1967).

The electron temperatures of static, optically thin H II regions related to 50,000, 40,000, and 30,000°K main sequence stars were determined as functions of the electron density and the dilution factor of the radiation for two different chemical compositions. In computing the heating of the electron gas, the formulas of Spitzer, and Burbidge, Gould, and Pottasch were used. It was found that in all cases the temperature is high close to the star; then it runs through a minimum at intermediate values of W, and finally it goes up again at larger distances from the exciting star. It is also concluded that the results are so strongly dependent on the assumed values of the parameters and the chosen treatment that agreement with all observational results can be obtained for particular ranges of values of the parameters. (auth)

37057 TECHNETIUM IN RED GIANTS. I. PRODUCTION MECHANISMS. Arnould, Marcel (Univ. Libre, Brussels). Ann. Astrophys., 30: 383-96(May-June 1967). (In French).

Different mechanisms for the nucleosynthesis of ^{99}Tc formed by the s process at different steps of stellar evolution are considered. The nuclear reactions starting at the Fe peak, which can produce the required number of neutrons are considered. For advanced-type stars there are many different such mechanisms. (auth)

37058 TECHNETIUM IN RED GIANTS. II. PROBABILITIES OF ^{99}Tc DISINTEGRATION UNDER STELLAR CONDITIONS AND RELATIVE ABUNDANCES. Arnould, Marcel (Univ. Libre, Brussels). Ann. Astrophys., 30: 397-419(May-June 1967). (In French).

The destruction mechanisms of ^{99}Tc into ^{99}Ru are considered. The β disintegration of the fundamental and first two excited levels of ^{99}Tc into ^{99}Ru and the degeneracy of the medium are taken into account. These two processes have opposite effects and their role is strongly dependent upon the adopted stellar model; their quantitative analysis can show how the degeneracy in inner regions of the red giants can increase ^{99}Tc abundance on their surface. Also a better time analysis of mixing in convective conditions is made possible. The results obtained lead to the computation of the relative abundances of ^{99}Tc and the neighboring elements in some nucleosynthetic processes which can occur in some stellar conditions. A spectroscopic criterium ($^{12}C/^{16}O$ ratio at the surface) is also discussed. (auth)

37059 THE RADIAL VELOCITY OF RU CAM DURING ITS RECENT QUIESCENT PHASE. Wallerstein, George; Crampton, David (Univ. of Washington, Seattle. Univ. of Toronto). Astrophys. J., 149: 225-7(July 1967).

The remarkable, sudden cessation of the light variation of the 22-day variable RU Cam permitted the investigation of certain aspects of stellar pulsation that are usually difficult of access in more conventional pulsating stars. During Jan. 1965, five coudé spectrograms of Ru Cam were obtained with the 120-inch coudé spectrograph at the Lick Observatory. One further spectrogram was secured in Oct. 1966, with the 36-inch camera of the 200-inch Hale Telescope. The velocity measures are plotted against phase. (W.D.M.)

37060 MIXING IN STELLAR INTERIORS CAUSED BY MAGNETIC FIELDS. Gurm, Hardev S.; Wentzel, Donat G. (Univ. of Michigan, Ann Arbor). Astrophys. J., 149: 139-44(July 1967).

Convection cells may rise in zones of radiative equilibrium when magnetic fields within the cells provide cohesion and buoyancy. The motion of such cells is evaluated both far from and near the edge of a radiative zone. For example, cells of radius $\lesssim 10^5$ km rise through the radiative zone of stars on the upper main sequence in a time less than the lifetime of these stars if the magnetic pressure in the cells is as small as 10^{-5} times the gas pressure. (auth)

37061 THE FINITE-AMPLITUDE OSCILLATIONS OF THE MACLAURIN SPHEROIDS. Rossner, Lawrence F. (Univ. of Chicago). Astrophys. J., 149: 145-68(July 1967).

The work of Dirichlet on the oscillations of self-gravitating, incompressible, homogeneous, ellipsoidal configurations was extended to treat the finite-amplitude oscillations of the Maclaurin spheroids which, in the limit of small amplitude, degenerate into their second-harmonic normal modes. These oscillations preserve the ellipsoidal nature of the surface and generate internal motions having a uniform vorticity. The problem is made tractable by the circumstance that the relevant partial differential equations of motion may be replaced by a set of ordinary differential equations, which have special integrals of the motion for the cases of interest. The results of analytic and numerical integration of these equations are given for the oscillations degenerating into that mode by which the Maclaurin spheroids become unstable. The nature of these oscillations is conveniently represented by trajectories in the (α_2, α_3) plane (where α_2 and α_3 are the lengths of two of the semi-axes of the ellipsoidal figure); and it is shown how these trajectories can be interpreted in terms of a particle-dynamical point of view incorporating such concepts as zero-velocity curves and isolating or nonisolating integrals of the motion. Computations were made for various choices of the unperturbed configuration, both stable and unstable, and various energies, both negative and positive, of the perturbed configuration. In particular, the results for the case of a highly oblate unstable Maclaurin spheroid suggest that the inclusion of dissipation could result in the ultimate assumption by such a configuration of a new stationary state which is highly prolate about one of its principal axes transverse to the axis of rotation. (auth)

37062 STATISTICAL-EQUILIBRIUM MODEL ATMOSPHERES FOR EARLY-TYPE STARS. I. HYDROGEN CONTINUA. Mihalas, Dimitri (Princeton Univ. Observatory, N. J.). Astrophys. J., 149: 169-90(July 1967).

Model atmospheres were constructed for selected effective temperatures and gravities appropriate to early-type stars, allowing in an approximate way for deviations from LTE in the first ten bound states of hydrogen. The essential approximation involved is the assumption of radiative detailed balance in the lines, which seems valid in the region of continuum formation. The resulting models are thought to be adequate for interpretation of the observed energy distribution of stars but cannot be used for discussions of line profiles. It is found that the deviations from LTE are quite small and that the predicted fluxes agree closely with those of LTE models. (auth)

37063 AN OBSERVATIONAL TEST FOR DEPARTURES FROM LTE IN THE SPECTRAL RANGE B5 TO A0. Strom, S. E.; Kalkofen, W. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). Astrophys. J., 149: 191-4(July 1967).

The ratio of observed Paschen to Balmer discontinuities is found to be a sensitive indicator, independent of stellar rotation, of departures from LTE in the spectral range B5 to A0. The ratio computed from model atmospheres that are not based on the assumption of LTE agrees better with existing photographic observations than does the ratio computed from LTE models. A program of the photoelectric observations necessary to verify this conclusion is suggested. (auth)

37064 CONSERVATIVE ANISOTROPIC SCATTERING IN A FINITE PLANE-PARALLEL ATMOSPHERE: T. W. MULLIKIN'S "CONSTRAINTS". Busbridge, I. W. (St. Hugh's Coll., Oxford). Astrophys. J., 149: 195-9(July 1967).

The constraints found by Mullikin for the fundamental functions in the conservative case are rederived. Some useful relations are also obtained. (auth)

37065 ALFVEN WAVES IN SUNSPOTS. Musman, Steven (Princeton Univ. Observatory, N. J.). Astrophys. J., 149: 201-9(July 1967).

Some form of nonradiative energy transport appears to be required in sunspots, and the possibility of Alfvén waves is examined here. A simple sunspot model is constructed in which Alfvén waves generated in a convectively unstable layer are permitted to propagate upward into an overlying stable layer. In the model investigated, only a very narrow range of physical conditions permits the growth of the waves, and it is concluded that waves of this sort are not likely to contribute significantly to energy transport in sunspots. (auth)

37066 SOME INTERMEDIATE COUPLING TRANSITION PROBABILITIES IN Ca XV AND Fe XIII. House, Lewis L. (High Altitude Observatory, Boulder, Colo.). Astrophys. J., 149: 211-16(July 1967).

Absolute line strengths and transition probabilities are calculated in the domain of intermediate coupling for the transition array $s^2p^2-sp^3$ in Ca XV and Fe XIII. The dipole integrals as well as the energy parameters are calculated from the Hartree–Fock program of Froese. Extrapolated wavelengths are given where sufficient empirical data are available; otherwise, theoretical Hartree–Fock energies are used to compute the wavelengths. The results clearly indicate the necessity for the use of intermediate coupling results where coronal statistical equilibrium problems are concerned. Several lines forbidden in LS coupling show strengths comparable to allowed resonance lines and should, there-

fore, be observable in the extreme ultraviolet spectrum of the solar corona. (auth)

37067 SOLAR–TERRESTRIAL RELATIONSHIPS. Tandon, J. N. (Univ. of Delhi). Indian J. Meteorol. Geophys., 14: 302-14 (July 1963).

Various features of geomagnetic storms are qualitatively explained on the basis of the focusing of solar-ion streams, taking account of the local and general solar magnetic field. It is shown that the streams emerging from the solar regions of large magnetic field may be dispersed, while they may emerge in the form of concentrated streams from quiet solar regions which do not possess large magnetic fields. Further qualitative explanations for the formation of coronal plumes near sunspots and of coronal streamers around sunspot minima are also given. (BBB)

37068 MICROWAVE RADIATION OF SINGLE CHARGED ^{3}He FROM H II REGIONS. Goldwire, H. C. Jr. (Rice Univ., Houston, Tex.); Goss, W. Miller. Astrophys. J., 149: 15-22 (July 1967).

The hyperfine structure of the ground state of ^{3}He II is discussed. The lifetime of the upper hyperfine state against spontaneous emission of 3.46-cm radiation is determined to be about 16,000 years. The spin temperature of ^{3}He II in H II regions is shown to be equal to the kinetic temperature of the regions. The expected intensity of the ground-state hyperfine transition radiation received from certain H II regions is shown to be near the limits of detectability by present techniques. It is shown that the microwave method can lead to the setting of an upper limit of 10^{-4}–10^{-5} for the ^{3}He to H abundance; this is contrasted with the current 10^{-2} upper limit established by optical means. Some of the important questions that may hinge upon the interstellar abundance of ^{3}He are delineated. (auth)

37069 ROTATIONAL TEMPERATURE OF CARBON STARS (CN RADICAL). Querci, F. (Observatoire de Toulouse). Ann. Astrophys., 30: 557-63 (May-June 1967). (In French).

The rotational temperature of the CN radical in some of the brightest carbon stars is determined by a detailed study of the relative intensities of the lines in the (4,0) band of the red system. The spectrograms used were obtained at the coudé focus of the 193 cm telescope of the Haute Provence Observatory (Dispersion 12.4 A^0/mm). (auth)

37070 PROPAGATION OF WAVES IN RANDOM MEDIA AND STOCHASTIC EQUATIONS. II. APPLICATIONS. Frisch, Uriel (Institut d'Astrophysique, Paris. New York Univ.). Ann. Astrophys., 30: 565-601 (May-June 1967). (In French).

Theoretical results of part I of this paper are applied to wave propagation and geometrical optics in random media, to multiple scattering of waves by randomly distributed scatterers, to the motion of particles in random force-fields (generalized Brownian motion), and to the density of electron energy levels in an impurity band. Among the applications of astrophysical interest are the heating of the solar corona by energy transfer from sound to Alfvén waves, stellar scintillation, and acceleration of cosmic rays by random electromagnetic fields. At last a parallel is drawn between linear stochastic equations and Prigogine's formulation of non-equilibrium statistical mechanics. (auth)

37071 OBSERVATION OF THE MAY 20, 1966 SOLAR ECLIPSE AT BORDEAUX AT 930 MHz. Poumeyrol, F. (Observatoire de Bordeaux). Ann. Astrophys., 30: 553-6 (May-June 1967). (In French).

The May 20, 1966 eclipse was observed on 32-cm wavelength. A visible active center can be found on the occultation curve. The brightness distribution on 32 cm seems much smoother than on 21 cm. (auth)

37072 STUDY OF MAGNETIC FIELDS IN THE ACTIVE SOLAR REGIONS. Semel, Meir (Observatoire de Meudon, France). Ann. Astrophys., 30: 513-51 (May-June 1967). (In French).

In order to study the magnetic fields in active regions in the sun, the shifts of Fraunhofer lines observed with circular polarization analysis were measured. It is shown that the displacements of the center of gravity of the observed profiles are practically proportional to the longitudinal component of the field. By numerical computation, comparison was made between the displacement of the center of gravity and measurements with lambdameter. The longitudinal component approximation was found valid in the case of the measurements. Therefore certain properties of magnetic fields in active centers according to the observation of the longitudinal component (total flux and electric current) were studied along with the correlation between the longitudinal components of the magnetic and velocity fields and particularly the colinearity of the two vectors. Some contradictions to such a colinearity were found. An attempt was made to establish a quantitative method to get more precise information about this problem. From the observation of the longitudinal component and under the supposition that no current exists above the photosphere, it is possible to calculate the complete configuration of the field. The method and the first results concerning a complex group are given. The results as well as the validity of the hypothesis are discussed and followed by an estimate of the current under the photosphere. (auth)

37073 SPECTRAL STUDY OF STAR HD 217050. Ozemre, Kamuran (Astronomi Kuersuesue, Istanbul). Ann. Astrophys., 30: 495-512 (May-June 1967). (In French).

The Be Star HD 217050 which shows a metal shell was studied from 8 high dispersion spectra taken at the Haute Provence Observatory. First a detailed analysis of the spectrum, identification of the central star type (B_2 III), variations of spectral line intensities, and apparent rotation velocity of the star and its shell are presented. The ratio V/R shows very small fluctuations and the analysis of complex spectral lines indicates that the shell is rotating. N_2H and N_e in the stellar atmosphere and the shell and also the helium abundance were determined; a curve of growth was built for the shell which leads to the evaluation of excitation, temperatures, and turbulent velocities for Fe II, Ti II, Cr II, Si II, and Mg I. The shell seems to be quite similar to the atmosphere of α Cyg with a somewhat higher temperature. (auth)

37074 STUDY OF THE CENTRAL REGION OF THE GALAXY. Cailliatte, Ch. (Observatoire de Lyon). Ann. Astrophys., 30: 471-93 (May-June 1967). (In French).

Photographic measurements in the blue and infrared were obtained with the 81- and 193-cm telescopes in Haute-Provence on stellar cloud B close to the globular cluster OHP 1 in an area 0.12 square degrees. They result in: (1) Total interstellar absorption is 2.2 to 2.3 magnitude, corresponding to a total photographic absorption of 5.5 to 5.8, which takes place between 1 and 3 kpc from the Sun and seems constant throughout the investigated area. (2) Fifteen variable stars, observable only in infrared, of which 9 belong to Mira Ceti type as deduced from their periods and amplitudes. They are concentrated in the central Galactic condensation and their mean modulus is m−M−absorption = 14.8 to 14.9 magnitude and their distance 9.1 to 9.6 kpc. (3) Some red giants of population II, one of them in OHP 1. (4) Very remote discrete absorbing clouds in the vicinity of the studied area which produce a total photographic absorption of 1 magnitude to be added to that found in paragraph 1. Infrared color indices were partially calibrated using observations of the galactic cluster H 15 which is nearby, it seems to belong to the Hyades class and to contain some subgiants. Finally an analysis of Schilt method for the microphotometric measurement of densities in stellar images with a variable iris is presented. (auth)

37075 MODELS OF ATMOSPHERES FOR COOL DWARF STARS. Kandel, Robert (Observatoire de Paris). Ann. Astrophys., 30: 439-69 (May-June 1967). (In French).

In order to compute model atmospheres for cool dwarf stars, one must study the equation of state of the stellar material at the appropriate temperatures and pressures, taking into account the formation of negative ions and molecules. The different sources of continuous and line absorption are reviewed and models are constructed which are (roughly) in radiative equilibrium. The stability of these models is evaluated, and a sequence of models of varying convection is computed, going from the model with no convection to the model stratified adiabatically. The "minimum convection" model is identified with the one in this sequence which just avoids a density inversion. The various models are interpreted with the mixing-length formalism, on the one hand using a "classical" mixing-length proportional to the scale height, on the other and assuming constant total energy flux and computing the mixing-length at each point. Finally the various models are compared: it is found that convection has a strong influence on the depth-dependence of the temperature (which may be described as an "inverted" blanketing effect), and this affects the boundary conditions for joining the model atmospheres to interior models; however, as far as the emergent continuum is concerned, the differences are small. (auth)

37076 FORMATION OF Ca II AND Mg II LINES IN THE LOWER CHROMOSPHERE. Dumont, Simone (Observatoire de Paris). Ann. Astrophys., 30: 421-37 (May-June 1967). (In French).

The equations of statistical equilibrium and the transfer equations for an atom of two to five discrete levels and a continuum in the cases of Ca II and Mg II ions and for a solar model are solved simultaneously. The profiles of resonance lines are obtained and the effect of the interlocking is observed. The source functions S_H and S_K of the H and K lines of the Ca II are different by about 20% at the surface. The error committed by Goldberg's method in evaluating $\Delta\lambda_D$ is estimated at 30%. (auth)

37077 STELLAR EVOLUTION AND THE BRANS-DICKE COSMOLOGICAL THEORY. Roeder, R. C. (Univ. of Toronto). Astrophys. J., 149: 131-8(July 1967).

It is shown that it is possible to construct a theoretical color–magnitude array representing a star cluster of age 3.0×10^9 years, using the variation of the gravitational "constant" indicated by the flat-space solution of the Brans–Dicke cosmological theory. (auth)

37078 THE EARLY EVOLUTION OF POPULATION II STARS. Demarque, Pierre (Univ. of Chicago). Astrophys. J., 149: 117-29(July 1967).

Results of calculations of stellar evolution from the main sequence are presented for a range of masses and chemical compositions applicable to subdwarfs and globular-cluster members. Twenty-two evolutionary tracks consisting of more than 770 models were obtained for the following compositions X = 0.999, 0.90, and 0.75 for Z = 0.001 and X = 0.99 and 0.76 for Z = 0.01. These tracks were used to construct isochrones in the M_{bol}–log T_{eff} diagram. It is emphasized that observed subdwarfs should not be compared with main-sequence models but rather with isochrones corresponding to their age and chemical composition. The slope of the observational data then favors a "normal" helium abundance. Other evidence, however, suggests the possibility of variations in helium content from one Population II object to another. Uncertainties in the radii of the stellar models in this region of the H–R diagram are discussed, and it appears that the only fully reliable coordinate in the H–R diagram to be obtained from the theory is the value of M_{bol} at the turnoff point. No gap above the turnoff point similar to the one observed in M67 and confirmed by Population I models is predicted in globular-cluster color–magnitude arrays. (auth)

37079 COLLINDER 121: A YOUNG SOUTHERN OPEN CLUSTER SIMILAR TO h AND χ PERSEI. Feinstein, Alejandro (Universidad Nacional de La Plate, Argentina). Astrophys. J., 149: 107-15(July 1967).

Three-color photoelectric photometry was carried out for stars in the open cluster Cr 121. The data state that the cluster is nearly identical to h and χ Persei but has fewer members. It was found that some bright and high-luminosity stars in Canis Major (γ, δ, η, ι, ξ^1, o^1, o^2, σ) are members of this cluster. A Wolf–Rayet star (HD 50896) may also be a member according to the observed colors. Its position in the color–magnitude diagram is close to the turnoff point of the main sequence. Cr 121 situated at a distance of 630 pc, and is as young as the double cluster in Perseus. The reddening is very small. (auth)

37080 ANALYSIS OF STELLAR CONTENT AND CEPHEID EVOLUTION IN NGC 1866. Arp, Halton (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 149: 91-106(July 1967).

Stars in the giant branch of the Large Magellanic Cloud star cluster, NGC 1866, are compared to theoretically computed evolutionary tracks for 5 $M_\odot$ stars. The over-all form of the observed tracks is in excellent agreement with the theoretical predictions. The detailed distribution of stars in the giant branch can be interpreted in either of two ways. Both adopted sequences require modifications to the theory near the end of the computed evolutionary tracks, where helium shell burning takes place; one interpretation of the giant sequence requires, in addition, that core helium burning at the top of the giant-branch starts at higher luminosity than is given by theory. Stellar populations in this range are compared in the Small Magellanic Cloud, the Large Magellanic Cloud, and the neighborhood of the Sun. It is shown that there is a progressive reddening of giant branches in the color–magnitude diagrams in this order. In NGC 1866 the giant branch barely penetrates into the Cepheid instability region. It is suggested that the greater penetration of the evolutionary tracks to the blue in the Small Cloud population at this luminosity accounts for its larger number of Cepheids, existence of Cepheids of shorter periods, and the bluer color indices of its Cepheids. This progressive change in properties from the SMC to the LMC to our Galaxy is interpreted as a progressive metal enrichment of the stellar population. The slope of the period–luminosity relation in NGC 1866 and the Magellanic Clouds is discussed. NGC 1866 is tentatively placed on the far side of the LMC. Finally, the NGC 1866 Cepheids are examined from the standpoint of possible differences among them which are not due to evolutionary stage but are intrinsic, that is, reflecting differences in initial formation conditions. (auth)

37081 THE STAR CLUSTER NGC 1866 AND ITS CEPHEIDS. Arp, Halton (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena); Thackeray, A. D. Astrophys. J., 149: 73-89(July 1967).

Colors and magnitudes of seven Cepheid variables and ninety-eight nonvariables were measured in the Large Magellanic Cloud star cluster, NGC 1866. An evolved main sequence of a few times 10^7 years in age and many red giants are seen in the color-magnitude diagram. The variables range between 2.6 and 3.5 days in period. They all turn out to have very similar amplitudes, light-curve shapes, and, unexpectedly, all closely the same color index. The region of the variables seems to be very sharply bounded on the red side. The sequences which emerge from the high-accuracy measures on the giant branch seem to confirm very well the general predictions of evolution in the giant phase by Hofmeister, Kippenhahn, and Weigert and by Iben. The cluster stars are similar to the younger stars that are numerous in the surrounding Large Magellanic Cloud field. (auth)

37082 SPECTROPHOTOMETRY OF NEW SHORT-PERIOD VARIABLE STARS. Danziger, I. J.; Dickens, R. J. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Contract AF49(638)-1323. Astrophys. J., 149: 55-72 (July 1967).

The occurrence of short-period variability in a number of bright F-type stars was discovered during an extensive program of UBV photoelectric observations made between October, 1965, and February, 1966. The amplitudes of the new variables are small and change in the manner shown by some of the variables of the δ Sct type. Observations of the continua of the new variables were made by measuring the intensities at twenty-five discrete wavelengths between about 3,300 and 10,000 Å using a photoelectric spectrum scanner. Coudé spectra at 10 Å/mm were used to correct the intensities for line-blanketing effects, and the resulting continua were then compared with the model atmospheres of Mihalas to yield effective temperatures and surface gravities. Some of the new variables have higher temperatures and gravities than the previously known variables. Higher values of the projected rotational velocity V sin i also occur, and indicate that in this region of the H–R diagram pulsation is not incompatible with rapid rotation. More than half the stars appear to be significantly undermassive for normal left-to-right evolution in the H–R diagram, for which masses ~1.8 $M_\odot$ are typical. Some of the variables, particularly ρ Pup and HR 5017, have extremely low values of the pulsation constant Q. The stars of lowest mass are consistently cooler than those of higher mass, an effect that is observable in a correlation obtained between log g and log T_e. (auth)

37083 A SPECTROPHOTOMETRIC STUDY OF DELTA SCUTI AND DELTA DELPHINI. Kuhi, L. V.; Danziger, I. J. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Contract AF49(638)-1323. Astrophys. J., 149: 47-53(July 1967).

The results of a simultaneous spectrophotometric and spectroscopic analysis of δ Scuti and δ Delphini are given and include the relative variations of light, temperature, and radial velocity. Delta Scuti has a light, temperature, and radial velocity variation of 0.15 mag, 250°K, and 9 km/sec, respectively. For δ Del the same quantities are 0.10 mag, 200°K, and 5.5 km/sec. Using the mean gravities given by log g ~2.8 and ~3.2, respectively, for δ Sct and δ Del, it is concluded that the value of Q in the period–density law is lower than theory would suggest. There also appears to be a difference in the masses of these two stars, which are lower than expected from their location in the H–R diagram. (auth)

37084 VARIABILITY OF THE DELTA SCUTI STARS. Leung, Kam-Ching (Univ. of Pennsylvania, Philadelphia); Wehlau, William. Astrophys. J., 149: 39-46(July 1967).

Photoelectric observations and improved Fourier components for δ Delphini are presented. Results of the Fourier analysis of four other δ Scuti type stars are tabulated. Comparison of light and radial-velocity curves shows that their amplitudes are proportional and that maximum light precedes minimum radial velocity by 0.1 period. (auth)

37085 THE HELIUM-RICH STAR HD 264111. Stephenson, C. B. (Case Inst. of Tech., Cleveland). Astrophys. J., 149: 35-8(July 1967).

The B2 star HD 264111, noted on an objective prism plate to show strong lines of He I, was observed with the Cassegrain spectrograph. The spectrum exhibits He I lines of unusually great strength, though a few stars exhibiting still stronger lines are known. The star is undoubtedly similar to HD 96446, which has been discussed by the Jascheks and by Buscombe. A rough analysis of equivalent widths indicates He : H = 1.0 by number; the He : H ratio is thus intermediate between normal stars and true helium stars. It is possible that the star is a subdwarf, and a proper motion of 0.032 per year has been determined. The radial velocity is rather large, in which sole respect the star resembles the helium stars somewhat more than it does HD 96446. (auth)

37086 FAR-ULTRAVIOLET INTERSTELLAR ABSORPTION LINES IN DELTA AND PI SCORPII. Stone, Michael E.; Morton,

Donald C. (Princeton Univ. Observatory, N. J.). Astrophys. J., 149: 29-34(July 1967).

Rocket ultraviolet spectra of the main-sequence B stars δ and π Scorpii revealed absorption lines of O I, C II, Si II, and Al II, which are believed to be interstellar. If broadening is by radiation damping, the equivalent widths yield interstellar densities of the ions directly. In an H I region the observed ions are those expected to have the majority of the population of their species, so that the ion densities are the element densities. Within the large uncertainties of the measurements, the abundance ratios of these elements are consistent with those of the Sun. However, if interstellar hydrogen is present in the solar proportion, the strengths of the observed lines correspond to the rather high hydrogen density of ~70 atoms cm^{-3}. Errors in the photometry seem insufficient to explain the discrepancy between this density and the 0.7 atom cm^{-3} found from the 21-cm emission. Hydrogen molecules could contribute as much as 5 times the atomic density, but it also seems necessary to postulate a dense cloud with relatively little hydrogen or dust, or excessive turbulent velocities so that the lines are Doppler broadened. (auth)

37087 THE ENERGIZATION OF THE INTERSTELLAR MEDIUM BY IONIZATION-LIMITED H II REGIONS. Lasker, Barry M. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 149: 23-8(July 1967).

Simple heuristic models, based on the results of previously available calculations, are presented for the dynamics of old H II regions, and the kinetic energy in the accelerated H I shell is obtained. The efficiency with which these ionization-limited H II regions transfer energy from the Lyman continuum of their exciting stars to the interstellar medium is estimated to be $\sim 10^{-2}$. The consequences of this concerning the energy balance of the interstellar gas are discussed. (auth)

37088 ABSOLUTE MEASUREMENTS OF THE RADIO FLUX FROM CASSIOPEIA A AND TAURUS A AT 3.64 AND 1.94 CM. Allen, R. J.; Barrett, A. H. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 149: 1-13(July 1967).

A cornucopia horn reflector antenna of 6.07 m^2 aperture area was used to make transit drift-scan observations of the radio sources Cassiopeia A and Taurus A during October–December, 1965, and January, 1966. The efficiency of the antenna is known from pattern range measurements, and the result is in good agreement with theoretical calculations. The receivers were examined for linearity and stability, and the gas-discharge calibration signals were measured using liquid-nitrogen-cooled terminations. The data were corrected for waveguide losses, atmospheric attenuation, and for linear polarization of the sources. No significant differences were found from the radio spectra obtained by other observers at lower frequencies. (auth)

37089 INTERPRETATION OF INTENSITIES IN DIATOMIC MOLECULAR SPECTRA. Tatum, J. B. (Dominion Astrophysical Observatory, Victoria, B. C.). Astrophys. J., 14: Suppl., 21-55(Mar. 1967).

The methods for calculating the relative populations of diatomic molecular energy levels and the absolute intensities of bands and lines in molecular spectra in terms of the appropriate molecular physical parameters are discussed in detail. (auth)

37090 INFRARED OPACITY OF HOT WATER VAPOR. Auman, Jason Jr. (Princeton Univ. Observatory, N. J.). Astrophys. J., 14: Suppl., 171-206(May 1967).

The opacity of water vapor was calculated in the spectral region between 0.8 and 12.5μ for temperatures of 1680, 2016, 2520, and 3360°K and for turbulent velocities of 2, 4, and 8 km/sec. The positions and the strengths of a total of approximately 2.3×10^6 spectral lines were calculated, and the water-vapor spectrum was reconstructed by summing the contributions of these lines. The harmonic mean of the opacity was calculated over intervals of 100 cm^{-1}. For stars with solar abundances water vapor is an important source of opacity for T = 3360°K and is the dominant source of opacity for T ≤ 2520°K. The results of the calculations are presented in such a way that the harmonic mean opacity including the opacity due to water can be calculated in intervals of 100 cm^{-1} for arbitrary values of the continuous opacity. (auth)

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Refer also to abstracts 37296, 37558, 38217, and 38769.

37091 (BMwF-FBK-67-56) WECHSELWIRKUNGEN VON SPALTPRODUKTIONEN MIT MATERIE. (Interactions of Fission Fragment Ions With Matter). Konecny, E.; Kerr, D.; Siegert, G.; Gunther, H. (Giessen Univ. (West Germany). Zweites Physikalisches Institut). June 1967. 28p. (In German). Dep.

The mass spectrometer installed at the Reaktorstation Garching has been used to investigate the interaction of high-energy heavy ions with matter. The results of an experiment in which the multiple and plural scattering distributions of fission fragments were measured can be reproduced by the theory of Molière while the theory of Nigam, Sundaresan and Wu predicts distribution widths that are as much as four times too large. The electron capture cross sections for fission fragments in air, helium, and methane were measured. (auth)

37092 (CEA-R-3192) IONISATION DES ATOMES HYDROGENOIDES PAR UN PROCESSUS D'ABSORPTION MULTIPHOTONIQUE. (Ionisation of Hydrogen-Like Atoms by a Multiphoton Absorption Process). Gontier, Yves; Trahin, Michel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1967. 31p. (In French). Dep.

The general expression for the amplitude of the probability of ionization by a multiphoton absorption process is derived. Its nonrelativistic limit is taken and the dipolar approximation is used for calculating the ionization cross section of hydrogen-like atoms. This latter involves the summation over intermediate virtual states by means of: (a) a recursion relationship concerning angular functions; (b) a particular technique which when applied to radial functions makes it possible to solve a system of inhomogeneous first-order differential equations. (auth)

37093 (CU-4-67) RESEARCH INVESTIGATION DIRECTED TOWARD EXTENDING THE USEFUL RANGE OF THE ELECTROMAGNETIC SPECTRUM. Progress Report No. 15, November 1, 1966–April 30, 1967. Novick, R. (Columbia Univ., New York. Columbia Radiation Lab.). Apr. 30, 1967. Contract DA 36-039 SC-90789. 105p.

The recently demonstrated optical excitation produced by collisions of low-energy ions with atoms and molecules contradicts the well-known adiabatic criterion. This criterion predicts large excitation cross sections only when the projectile velocity is comparable with the classical velocity for electrons in the target. A detailed study was made of the excitation of helium atoms to the n = 3, 4, 5 triplet and singlet states by bombardment with 50- to 5000-eV helium ions. A new type of optical double quantum transition has been observed in which an atom passes from one Zeeman sublevel to another by virtual absorption and successive re-emission of optical photons. A remarkable property of these transitions is that the energies of the optical photons involved are on the order of 10^{10} times larger than the energy difference between the initial and final states of the Zeeman transition. New results from coherent laser scattering in xenon are summarized. In general, the results complement earlier measurements farther from the transition point and extend them smoothly to within 5 ppM of the critical temperature. The coefficient of isothermal compressibility on the critical isochore is found to diverge as $(T-T_c)^{-1.1\pm0.1}$, which is distinctly slower than $(T-T_c)^{-1.25\pm0.1}$ found when $T-T_c > 10^{-3}\ T_c$. A large-area x-ray gathering system has been constructed and has been subjected to vibration and geometrical tests. Results of these tests show that the system is mechanically suitable for use in an Aerobee 150 sounding rocket. Use of the high-energy cutoff of the reflectivity of the surfaces in the gathering system makes simpler the observation of low-energy spectra of astronomical x-ray sources, especially in those cases where the high-energy flux is substantially greater than the low-energy flux. (auth)

37094 (LA-3690) ATOMIC STRUCTURE CALCULATIONS. I. HARTREE–FOCK ENERGY RESULTS FOR THE ELEMENTS HYDROGEN TO LAWRENCIUM. Mann, Joseph B. (Los Alamos Scientific Lab., N. Mex.). May 1, 1967. Contract W-7405-eng-36. 77p. Dep. CFSTI.

Hartree–Fock calculations of the electronic structure and energies of the elements from hydrogen to lawrencium were made. Exchange terms were included without approximation. Tabulations of total atom energies, orbital binding energies, I, F, and G energy integrals, and orthogonality parameters ϵ_{ij} for open shells are presented here. The procedures for solving the Hartree–Fock equations on the IBM 7030 (Stretch) computer are described. (auth)

37095 (MATT-551) A DIGITAL COMPUTER PROGRAM FOR COMPUTING ION SATURATION CURRENTS FROM A PLASMA OF UNIFORM DENSITY IN A TWO-DIMENSIONAL GEOMETRY. Harrison, John L. (Princeton Univ., N. J. Plasma Physics Lab.). Aug. 1967. Contract AT(30-1)-1238. 42p. Dep. CFSTI.

The shape of the surface from which ions are extracted is a major factor in determining the tractability of an ion beam for fine focusing. In duoplasmatron-type ion sources the extraction is made from a plasma, and the shape of the plasma surface has been difficult to define. A computer program is described which both determines the shape of plasma surface in a known extraction geometry with known current density at the surface and calculates trajectories of particles leaving this surface. (auth)

37096 (NASA-TN-D-4097) FORTRAN IV PROGRAM FOR CALCULATION OF THERMODYNAMIC DATA. McBride, Bonnie J.; Gordon, Sanford (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Aug. 1967. 129p. CFSTI.

A FORTRAN IV program is described which (1) calculates thermodynamic functions (heat capacity, enthalpy, entropy, and free energy), (2) fits these functions to empirical equations, and (3) calculates, as a function of temperature, heats of formation and equilibrium constants. The program provides several methods for calculating ideal gas properties. For monatomic gases, three methods are given which differ in the technique used for truncating the partition function. For diatomic and polyatomic molecules, five methods are given which differ in the corrections to the rigid-rotator harmonic-oscillator approximation. In addition the program provides for calculating thermodynamic functions for solids, liquids, and gases from empirical heat capacity equations. (auth)

37097 (NYO-3829-9) K-, L-, AND M-SHELL ATOMIC PHOTOEFFECT FOR SCREENED POTENTIAL MODELS, SUPPLEMENT A. TABLES OF CALCULATED PHOTOELECTRIC CROSS SECTIONS FOR ENERGIES 10 TO 3000 keV. Schmickley, R. D.; Pratt, R. H. (Lockheed Missiles and Space Co., Palo Alto, Calif. Research Labs.). June 1967. 12p. (LMSC-5-10-67-11). Dep. CFSTI.

Tables are presented of theoretical predictions for total photoelectric cross sections (integrated over all angles, averaged over initial photon polarizations, and summed over final electron spins) for each subshell K, L_I, L_{II}, L_{III}, for each shell K, L, M, with estimates for N + O + ..., and for complete atoms K + L + M + ... The report is a tabular supplement to an article submitted for publication in The Physical Review, in which discussion of the theory, methods of calculation, errors, and comparison with experiment can be found. (A.G.W.)

37098 (NYO-3829-10(Suppl.B)) K-, L-, AND M-SHELL ATOMIC PHOTOEFFECT FOR SCREENED POTENTIAL MODELS. SUPPLEMENT B. TABLES OF CALCULATED PHOTOELECTRIC ANGULAR DISTRIBUTIONS AND POLARIZATION CORRELATIONS FOR SELECTED ELEMENTS AND X-RAY ENERGIES. Schmickley, R. D. (Lockheed Missiles and Space Co., Palo Alto, Calif. Lockheed Palo Alto Research Lab.); Pratt, R. H. (Pittsburgh Univ., Pa. Dept. of Physics). June 1967. Contract AT(30-1)-3829. 68p. (LMSC-5-10-67-12(Suppl.B)). Dep. CFSTI.

The tables give theoretical angular distributions and polarization correlations for photoelectrons ejected from subshells K through M_V of selected elements and energies. Most of the data are for Z = 26, 47, 50, or 92 and $h\nu$ = 412, 662, or 1332 keV. These functions are the results of numerical calculations described in Phys. Rev. (to be published), and this paper is a tabular supplement to that article. (W.D.M.)

37099 (ORNL-P-3204) ELECTRON SPECTROMETRY OF DOUBLE-ELECTRON EJECTION FROM RARE GAS ATOMS IN THE PHOTOABSORPTION PROCESS. Krause, Manfred O. (Oak Ridge National Lab., Tenn.). [1967]. Contract W-7405-eng-26. 3p. (CONF-670534-3). Dep. CFSTI.

From 15th Annual Conference on Mass Spectrometry and Allied Topics, Denver, Colo.

Targets of various rare gas atoms were irradiated with x rays and the emitted electrons were analyzed with an electrostatic energy analyzer. The discrete line spectrum and the continuous spectrum that contains the more energetic of the two emitted electrons were scanned. (M.O.W.)

37100 (ORNL-P-3226) INTERACTION OF MONOENERGETIC Ar^+ (.5 TO 8 keV) WITH A Cu (100) TARGET: SPUTTERING AND ION SCATTERING. Woodyard, James R. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 2p. (CONF-670534-4). Dep. CFSTI.

From 15th Annual Conference on Mass Spectrometry and Allied Topics, Denver, Colo.

A summary is given of studies of particles emitted from a Cu(100) target when bombarded by 0.5 to 8 keV Ar^+ ions. The target was rotated about a ⟨100⟩ axis and the particles emitted at a 90° angle with respect to the incoming beam were analyzed with a mass spectrometer. (auth)

37101 (ORNL-TM-1850) NON-ADIABATICITY CORRECTIONS TO THE BORN-OPPENHEIMER APPROXIMATION WITH CALCULATIONS FOR MESIC AND ELECTRONIC HYDROGEN MOLECULAR IONS. Patterson, M. R.; Becker, R. L. (Oak Ridge National Lab., Tenn.). Aug. 1967. Contract W-7405-eng-26. 217p. Dep. CFSTI.

Thesis. Submitted by M. R. Patterson to Univ. of Tennessee, Knoxville.

For generalized hydrogen molecular ions the adiabatic approximation is excellent if $\epsilon/4$, the ratio of the mass m_3 of the binding particle to the total mass, is small (e.g., H_2^+). For $(p\mu p)^+$, ϵ = 0.213, the large mass ratio introduces correction terms to the adiabatic approximation. A detailed formalism using rotation matrices and exact two-center "electronic" functions was worked out. The nonadiabatic corrections take the form of couplings between different electronic states. Coupled radial equations involving as many as six electronic states have been solved for ground and excited states of $(p\mu p)^+$, $(d\mu d)^+$, $(t\mu t)^+$, $(\mu e\mu)^+$, and $(pep)^+$. The resultant wave functions were used to calculate the probability 2γ that the lepton and either nucleus coincide. For ortho $(p\mu p)^+$ a new upper limit is $2\gamma_0 = 1.12$, as compared to the adiabatic value $2\gamma_0 = 1.165$. Variational calculations supply the lower limit $2\gamma_0 = 1.00$. Using the value $2\gamma_0 = 1.12$, the weak interaction coupling constants for muon capture in hydrogen are consistent with those for muon capture in ^3He and ^{40}Ca at the axial vector coupling constant values $g_A^{(\mu)}/g_V^{(\beta)} = -1.26\ ^{+0.08}_{-0.04}$ and the induced pseudoscalar coupling constant values $g_p^{(\mu)}/g_A^{(\mu)} = 16.2 \pm 3.2$. (auth)

37102 (USNRDL-TR-67-78) DERIVATION OF THE GENERALIZED MASTER EQUATION FOR COMPOSITE PARTICLES. Mitchell, J. D.; Schieve, W. C. (Naval Radiological Defense Lab., San Francisco, Calif.). July 10, 1967. 50p. CFSTI.

Generalized master equations for composite particles are derived. The methods of Girardeau are used to construct the appropriate representation of the density matrix for particles having internal degrees of freedom. The proper exchange symmetry between particles is described as an initial condition on the von Neumann–Liouville equation. The generalized master equations are then obtained for diagonal and off-diagonal matrix elements by a generalization of the projection technique of Zwanzig. The form of the equations is shown to be exactly the same as that obtained by Prigogine for structureless particles. The $\lambda^2 t$ approximation is discussed and it is shown that in this limit the particles will approach an equilibrium state in which exchange between the composite particles may be ignored. (auth)

37103 (UUIP-540) THE SPECTRUM O(IV). Bromander, Jan (Uppsala Univ. (Sweden). Inst. of Physics). May 1967. 33p. Dep.

The spectrum of triply ionized oxygen, was studied in the wavelength region 500 to 8000 Å. On the basis of the new measurements, made in this investigation and by Palenius (1967), together with a number of Edlen's (1934) lines below 500 Å, the term system was recalculated. The doublet and quartet systems are connected through four intercombination lines of the multiplet $2s^22p\ ^2P - 2s2p^2\ ^4P$. The ionization limit was determined to be 624,383.7 cm^{-1} (77.417 eV). (auth) (Swed)

37104 CALCULATIONS OF THE ENERGY AND ANGULAR DISTRIBUTION OF ELECTRONS EJECTED FROM HELIUM BY PROTONS. II. Oldham, William J. B. Jr. (Manned Spacecraft Center, Houston, Tex.). Phys. Rev., 161: 1-6(Sept. 5, 1967).

Doubly differential cross sections (ddcs), for ejection of secondary electrons of various energies and at various angles from helium bombarded by fast protons, have been calculated using the Born approximation. The wave functions of helium are approximated by products of one-electron orbitals. Results for the ddcs are given for several different choices of the one-electron orbitals, and these are compared with recent experimental values corresponding to 200- and 300-keV incident protons. (auth)

37105 COMPOUND STATE RESONANCES IN MOLECULAR COLLISIONS: THE INTEGRAL ELASTIC CROSS SECTION FOR D_2–Xe SCATTERING. Micha, David A. (Univ. of Wisconsin, Madison). Chem. Phys. Lett., 1: 139-42(June 1967).

Compound state resonances in molecular collisions are predicted, and numerical results are presented for the D_2–Xe system. (auth)

37106 DISCHARGE NUCLEAR POLARIZATION IN ^3He GAS. McCall, Gene H.; Carver, Thomas R. (Princeton Univ., N. J.). Phys. Rev. Lett., 19: 485-7(Aug. 28, 1967).

The existence of substantial polarization effects, apparently involving the 2^3S_1 metastable state, is produced by maintaining a discharge in a ^3He sample which is placed in a magnetic field. A polarization of 0.06%, which corresponds to an enhancement of 2200, has been produced at 1 kG. A partially successful theoretical explanation is discussed. (auth)

37107 SCATTERING OF RADIATION FROM INTERACTING ATOMS. Fontana, Peter R.; Hearn, Dwight D. (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett., 19: 481-5(Aug. 28, 1967).

The resonance fluorescence of a system of two identical, interacting atoms is investigated when the atoms are separated by distances that are large compared with atomic size. The inter-

actions between the atoms and the radiation field and the electrostatic interaction between the atoms are considered, and it was found that the line shape of the emitted radiation consists of two peaks whose amplitude, separation, and width are functions of the internuclear distance R of the atoms. The peaks are distinct at smaller separations, and, as R increases, rapidly merge to the characteristic line shape of a single, isolated atom. (auth)

37108 INELASTIC SCATTERING OF ELECTRONS HAVING SPECIFIC ENERGIES IN THIN FILMS OF GOLD. Nakhodkin, N. G.; Mel'nik, P. V. (Shevchenko State Univ., Kiev). Sov. Phys.-Solid State (Engl. Transl.), 9: 567-70(Sept. 1967). Translated from Fiz. Tverd. Tela, 9: 723-7(Mar. 1967).

An experimental study was made of the dependence on the thickness of the secondary and photoelectron currents, emitted in a narrow range of energies and solid angles, from a gold film on a carbon substrate. The model of continuous losses was used to give a qualitative explanation of the differences between the differential secondary electron emission and x-ray photoeffect curves. (auth)

37109 EXCITATION OF THE He_{II} λ4686-A LINE BY ELECTRON IMPACT. Weaver, L. D.; Hughes, R. H. (Univ. of Arkansas, Fayetteville). J. Chem. Phys., 47: 346-7(July 1, 1967).

Cross sections for excitation of the He^+ λ4686-Å line and the He λ4713-Å line by electron impact on He were measured. A peak value of 10.2×10^{-21} cm^2 was obtained for the He^+ line. Results are compared with those of other investigators. (A.G.W.)

37110 DISSOCIATION OF H_2^+ BY ELECTRON IMPACT: CALCULATED ANGULAR DISTRIBUTION. Zare, Richard N. (Univ. of Colorado, Boulder). J. Chem. Phys., 47: 204-15 (July 1, 1967).

The angular distribution of products in the electron impact dissociation of H_2^+ has been calculated following closely the Born approximation treatment of E. H. Kerner [Phys. Rev. 92, 1441 (1953)]. When the translational kinetic energy of separation greatly exceeds the initial rotational energy of the molecule, as is normally the case, the fragments are ejected nearly along the molecular axis. For "axial recoil" the leading term in the differential cross section shows a cosine-squared anisotropy peaked about the momentum-transfer vector, independent of the initial rotational state of the molecule. This is in contrast to the findings of Kerner. The inclusion of higher-order terms in the differential cross section produces interference effects, which shift the maximum of the angular distribution away from the momentum-transfer vector towards larger angles. However, the contribution of the leading dipole term strongly overshadows the effects of the higher-order multiple terms except in certain cases quite close to threshold. When the angular distribution of products is measured about the electron-beam direction k_0, rather than the momentum transfer vector K, the anisotropy assumes in the dipole limit a simple form proportional to $I_k(\theta) = \cos^2\theta' \cos^2\theta + \frac{1}{2} \sin^2\theta' \sin^2\theta$, where θ' is the angle included between k_0 and K. Upon integrating over all possible values of K for a fixed electron-impact energy, the form of the anisotropy is found to be a maximum close to threshold, but is first degraded and then reversed in sense as the bombarding energy is increased. In the high-energy limit, however, the angular distribution does not approach a sine-squared anisotropy, but rather a limiting form is asymptotically approached corresponding to an average θ' of about 68°. Comparisons are made with the related experimental studies of G. H. Dunn and L. J. Kieffer [Phys. Rev. 132, 2109 (1963)] on the dissociative ionization of H_2. (auth)

37111 ELECTRON IMPACT CROSS SECTIONS FOR ATMOSPHERIC SPECIES. 3. MOLECULAR OXYGEN. Watson, C. E.; Dulock, V. A. Jr.; Stolarski, R. S.; Green, A. E. S. (Univ. of Florida, Gainesville). J. Geophys. Res., 72: 3961-6(Aug. 1, 1967).

Using a modification of the Born Approximation, a diverse body of experimental data related to molecular oxygen was synthesized into a set of analytic electron impact cross sections. The generalized oscillator strengths of E. N. Lassettre, S. M. Silverman, and M. E. Krasnow serve as the primary data. In addition, optical data summarized by F. R. Gilmore are applied to the problem. Also, the involvements of vibrational excitation and Franck–Condon factors in cross sections are discussed. Finally, parameters for the cross sections for the simple analytic form of A. E. S. Green and C. A. Barth are given since these are more convenient for the purposes of application to atmospheric problems. (auth)

37112 ELECTRON IMPACT CROSS SECTIONS FOR ATMOSPHERIC SPECIES. 2. MOLECULAR NITROGEN. Stolarski, R. S.; Dulock, V. A. Jr.; Watson, C. E.; Green, A. E. S. (Univ. of Florida, Gainesville). J. Geophys. Res., 72: 3953-60(Aug. 1, 1967).

Using a modification of the Born Approximation, a diverse body of experimental data related to molecular nitrogen was synthesized into a set of analytic electron impact excitation and ionization cross sections. The generalized oscillator strengths of E. N. Lassettre, M. E. Krasnow, and A. Skeberle, and S. M. Silverman, serve as the primary data. However, relative angular distributions at low energies by C. B. O. Mohr and F. H. Nicholl are also used. In addition, optical data summarized by F. R. Gilmore, R. S. Mullikan, and G. R. Cook and M. Ogawa, and measured recently by R. E. Huffman, Y. Tanaka, and J. C. Larrabee, are applied to the problem. Also, the involvements of vibrational excitation and Franck–Condon factors in cross sections are discussed. Finally, parameters for the total cross sections using the simple analytic form of A. E. S. Green and C. A. Barth are given since these are more convenient for the purposes of application to atmospheric problems. (auth)

37113 ELECTRON IMPACT CROSS SECTIONS FOR ATMOSPHERIC SPECIES. 1. HELIUM. Jusick, A. T.; Watson, C. E.; Peterson, L. R.; Green, A. E. S. (Univ. of Florida, Gainesville). J. Geophys. Res., 72: 3943-51(Aug. 1, 1967).

The semi-empirical method for determining electron impact cross sections is used to determine sets of collision cross sections for helium. The parameters are evaluated using experimental angular distribution data, total cross section data, high-energy experimental generalized oscillator strengths, and theoretical optical oscillator strengths. The results for total excitation and ionization cross sections are also presented in a simplified empirical form that is more convenient for applications to electron loss calculations. The analysis points to remaining questions of consistency of data that will have to be resolved by future experiments or more refined theoretical calculations. (auth)

37114 SEMI-EMPIRICAL CROSS SECTIONS FOR ELECTRON IMPACTS. Green, A. E. S.; Dutta, S. K. (Univ. of Florida, Gainesville). J. Geophys. Res., 72: 3933-41(Aug. 1, 1967).

The Born Approximation is used in conjunction with recent helium functions to derive generalized oscillator strengths for various inelastic allowed transitions. These rather complex expressions can be represented accurately by simple analytically integrable forms that lead to analytical total cross sections. The parameters in the formula can be related to radial transition matrix elements. Extensions of the analytic technique to forbidden transitions and ionization cross sections are given. The latter extension is carried out in conjunction with a discussion of the Bethe continuum surface. The analytic treatment that may be applicable to any substance provides a useful way of using fragmentary electron impact data together with optical data and theoretical radial matrix elements to establish complete sets of differential and total cross sections at high energies. In addition it lends itself to empirical modification to encompass low-energy data. (auth)

37115 RADIATIVE TRANSFER IN A FREE-ELECTRON ATMOSPHERE. Siewert, C. E.; Fraley, S. K. (North Carolina State Univ., Raleigh). Ann. Phys. (N.Y.), 43: 338-59(June 16, 1967).

The equations of radiative transfer for an electron-scattering atmosphere, as developed by Chandrasekhar, are solved using Case's method of singular eigensolutions. The eigenfunctions of the set of coupled transport equations have been found. There are two discrete eigenvectors and two linearly independent, degenerate, singular, continuum eigensolutions. These eigenvectors are shown to form a complete basis set for the expansion of arbitrary two-component vectors defined on the half-range. In addition, all of the necessary adjoint functions have been developed so that all expansion coefficients can be obtained by taking scalar products. As an example of the method, the Milne problem is solved and explicit results are obtained for the two components of the polarized radiation field at any optical depth in the stellar medium. (auth)

37116 ENERGY SPECTRA OF INELASTICALLY SCATTERED ELECTRONS AND LEED STUDIES OF TUNGSTEN. Tharp, L. N.; Scheibner, E. J. (Georgia Inst. of Tech., Atlanta). J. Appl. Phys., 38: 3320-30(July 1967).

Energy distributions of the electrons inelastically scattered from the tungsten (110) surface for primary energies of 50 to 350 eV have been obtained using a modified LEED system. The information contained in these secondary electron energy distributions has been coupled with LEED patterns, thereby affording a more complete understanding of the electron scattering processes in the low-energy range. The physical processes contributing to the characteristic losses and other features observed in the energy spectra are discussed, and the expected behaviors are compared with experimental observations. LEED patterns are used to characterize sample-surface conditions. (auth)

37117 COMMENT ON "POSITRON FOCUSING IN AN ACCELERATING FIELD." Nickle, H. H. (Dublin Inst. for Advanced Studies). J. Appl. Phys., 38: 3212-14(July 1967).

It is pointed out that the idealized problem of positron focusing considered by G. W. Hong (J. Appl. Phys., 36: 2306(1965)) has a simple analytical solution, but the properties of the exact solution do not agree at all with the approximate solution obtained by Hong's iterative procedure. In addition, the idealized problem considered by Hong completely ignores two factors that may play decisive roles in any practical focusing scheme. (auth)

37118 DETERMINATION OF ANISOTROPIC MOMENTUM DISTRIBUTIONS IN POSITRON ANNIHILATION. Mijnarends, P. E. (Reactor Centrum Nederland, Petten, Netherlands). Phys. Rev., 160: 512-19(Aug. 15, 1967).

A theoretical method is presented, which permits the experimental determination of the momentum distribution of the photon pairs originating in positron annihilation in crystalline solids as a function of both the magnitude and the direction of that momentum. The distribution is expanded in a series of lattice harmonics. It is shown how linear combinations of the two-quantum angular correlations, obtained from measurements on a number of suitably oriented single crystals, may be unfolded to yield the momentum-dependent coefficients in that expansion. The method is illustrated by a model computation. (auth)

37119 PARTIAL-WAVE SCATTERING BY NON-SPHERICALLY-SYMMETRIC POTENTIALS. I. GENERAL THEORY OF ELASTIC SCATTERING. Boardman, A. D. (Univ. of Salford, Lancashire, Eng.); Hill, A. D.; Sampanthar, S. Phys. Rev., 160: 472-5(Aug. 15, 1967).

A general method is developed to obtain the elastic-scattering cross section of an asymmetric potential $V(r) = \Sigma_l v_l(r) P_l(\hat{\Omega}_l \cdot \hat{r})$ where the potential is expanded as a sum of multipoles and $\hat{\Omega}_l$ is a unit vector along the 2l-pole axis. It is assumed that $v_l(r)$ is effectively zero beyond a cutoff radius R and the resulting set of coupled differential equations is solved in terms of a scattering matrix S. A general expression for the scattering amplitude f(k,k') is derived in terms of the elements of S and 3j symbols. Finally, as an example, the method is applied to the problem of calculating the total and momentum-transfer cross sections for a randomly orientated set of axially symmetric centers. (auth)

37120 IONIZATION OF ATOMS BY COLLISION WITH EXCITED ATOMS. II. A FORMULA WITHOUT THE ROTATING-ATOM APPROXIMATION. Watanabe, Tsutomu; Katsuura, Kanji (Univ. of Notre Dame, Ind.). J. Chem. Phys., 47: 800-11(July 15, 1967). (COO-38-490).

A formula for the cross section of the ionization of an atom colliding with an excited atom, $A^* + B \rightarrow A + B^+ + e$, was obtained. The calculations to the formula were restricted to the case where the transition $A \rightarrow A^*$ is optically allowed and the excitation energy of A^* exceeds the ionization potential of B as before. Here all degenerate states of A^* and B + e were taken into account. The present formula gives a cross section 23% smaller than the previous result calculated by the use of the rotating-atom approximation. Besides numerical calculations, an approximation method for the basic equations of the present problem is also shown. This method gives the upper and lower bounds of the approximate cross sections obtainable from the basic equations. Other similar calculations were compared with the present results. (auth)

37121 ELECTRON BINDING ENERGIES FOR HIGHLY IONIZED FISSION-FRAGMENT ATOMS. Watson, R. L.; Rasmussen, J. O. (Univ. of California, Berkeley). J. Chem. Phys., 47: 778-83(July 15, 1967). (UCRL-17290).

Because of the large velocities attained by fission fragments immediately upon fissioning, they are unable to carry along many of their outer orbital electrons and hence become highly ionized. The state of ionization in turn directly affects the binding energies of the various remaining electrons. The K- and L-electron binding energies were calculated for the typical fission-fragment atoms Sr, Pd, Xe, and Sm in a number of ionic charge states ranging from the neutral state to the single-electron state (ionic charge of Z − 1). These calculated binding energies have been used to determine an empirical formula for computing the binding energies of atoms from Z = 34 to Z = 66 in any state of ionization with an estimated accuracy of ±80 eV. It was found that the K and L binding energies are both increased over the neutral atomic values by approximately 0.9 keV for the most probable ionic charges of the fission fragments (20+ to 26+), and consequently that the K x-ray energies are almost unaffected. (auth)

37122 SIMPLE APPROXIMATIONS TO THE ONE-ELECTRON WAVEFUNCTIONS. Tietz, T. (Univ. of Lodz, Poland). J. Chem. Phys., 47: 870-1(July 15, 1967).

The approximation to the 1s one-electron wave function is written in the form $y_{10} = r^s \exp(-\alpha_{10} r)$, where s is a constant and α_{10} is the eigenvalue. From this equation, the Schroedinger equation, and values of the constants involved determined from experimental data, the approximation for the wave function is obtained. A similar procedure is used to obtain wave-function approximations for other states. (A.G.W.)

37123 IS N_3 PRODUCED IN REACTIONS BETWEEN N_4^+ AND N_2? Maier II, William B. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 47: 859-60(July 15, 1967). (LA-DC-8727)

Results of an experimental study of reactions between N_4^+ and N_2 are interpreted in terms of $N_4^+ + N_2 \rightarrow N^+ + N + N_2$. Discrepancies between these results and results of Leventhal and Friedman [J. Chem. Phys., 46: 997(1967)], from which formation of N_3 was inferred, are considered. It is concluded that the present data do not disprove the existence of N_3 but do suggest that the dissociation energy $D(N_2-N)$ may be small. (A.G.W.)

37124 STOPPING CROSS SECTIONS OF METALLIC FILMS FOR LOW-ENERGY PROTONS. Morita, Kenji; Akimune, Hideo; Suita, Tokuo (Osaka Univ.). J. Phys. Soc. Jap., 22: 1503(June 1967).

Stopping cross sections of vacuum-deposited films of Al, Be, Cu, Ag, and Au were measured for protons in the energy range 7 to 35 keV. The measured cross sections were approximately proportional to $E^{0.4}$ in this energy range, and at a given energy the cross sections are approximately proportional to $\sqrt{Z}$ where Z is the atomic number of the substance penetrated. (A.G.W.)

37125 EFFECTIVE ELECTRON DENSITY FOR FREE-POSITRON ANNIHILATION IN LOW-Z COMPOUNDS. Bussolati, C.; Cova, S.; Zappa, L. (Istituto di Fisica del Politecnico, Milan. CNR, Milan). Nuovo Cim. (10), 50B: 256-62(Aug. 11, 1967).

Time spectra of positrons annihilating in various low-Z compounds, mostly liquids at room temperature, were investigated. They can be consistently resolved into three components which can be ascribed to the ortho- and para-positronium decay and to the annihilation of free positrons. The lifetime of this last component is interpreted in terms of Dirac's formula and it is shown that each atom contributes to the decay rate with an amount typical of the atom itself, i.e., independent of the structural properties of the molecule and of the material. For H, Li, B, C, O, and Cl the number of effective electrons per atom is obtained. (auth)

37126 POLARIZATION OF LIGHT EMITTED FROM THE EXCITATION OF H_2 BY ELECTRON IMPACT. Cahill, Patrick; Schwartz, Richard (Columbia Univ., New York). Phys. Rev. Lett., 19: 283-4(Aug. 7, 1967).

During the last few years several experimental investigations have been made on the polarization of atomic line radiation excited by electron impact. The measurement of the polarization of molecular line radiation excited by electrons in a single collision process is reported here for the first time. This observation of polarization affords a convenient experimental technique for the study of the fine and hyperfine structure in short-lived molecular states. (W.D.M.)

37127 NEGATIVE ELECTRON CYCLOTRON RESONANCE ABSORPTION DUE TO COLLISIONS. Wachtel, J. M.; Hirshfield, J. L. (Yale Univ., New Haven). Phys. Rev. Lett., 19: 293-5(Aug. 7, 1967).

An experiment is described in which the detailed nature of the negative cyclotron resonance absorption due to the elastic collisions of electrons with xenon is revealed by using nearly monoenergetic electrons. The results are compared with the predictions of the well-known kinetic theory of waves in plasmas. (M.H.R.)

37128 ABSOLUTE EXCITATION CROSS SECTIONS OF ATOMIC LEVELS OF ALKALI METALS FOR LOW-ENERGY ELECTRONS. Zapesochnyi, I. P. (Uzhgorod State Univ., USSR). Teplofiz. Vys. Temp., 5: 7-13(Jan.-Feb. 1967). (In Russian).

Measurements were made of the effective cross sections of sodium, potassium, rubidium, and cesium lower levels of excitation by collisions with 0- to 30-eV electrons. Two maximums were found for the resonance levels, one of which was in the immediate proximity of the excitation threshold. It is shown that an exceedingly sharp drop in excitation cross sections was observed in all atoms with increasing n. The role of cascade transitions during electron excitation of ^2S, ^2P, and ^2D levels was studied. The dependence of maximum excitation cross sections of ^2S and ^2D levels on the main quantum and atomic numbers of the element was determined and its analytic form was found. The magnitudes of lithium atom excitation cross sections were predicted, and theoretical and experimental data were compared. (tr-auth)

37129 EXCITATION OF ATOMS BY HEAVY PARTICLES. Vinogradov, A. V. Opt. Spectrosc. (USSR)(Engl. Transl.), 22: 361-2(Apr. 1967).

Translated from Opt. Spektrosk., 22: 663-4(Apr. 1967).

Problems of inelastic collisions of heavy particles, in which the quasiclassical approximation is used, are discussed. The total quantum-mechanical and quasiclassical cross sections are compared for different orders of perturbation theory. (M.O.W.)

37130 FIRST-APPROXIMATION CORRELATION CORRECTIONS TO THE POLARIZABILITY AND SCREENING FACTORS OF ATOMS. Evdokimov, V. M. Opt. Spectrosc. (USSR) (Engl. Transl.), 22: 287-90(Apr. 1967).

Translated from Opt. Spektrosk., 22: 521-8(Apr. 1967).

The influence of correlations to the polarizabilities and screening parameters is examined to a first approximation on the basis of the interaction between single-particle Hartree–Fock states. Corrections for the helium-like series are calculated. (auth)

37131 CHERENKOV RADIATION OF A MODULATED CHARGED BEAM IN PASSING THROUGH A SLIT IN A SOLID BODY. Pkhakadze, M. G. (Inst. of Physics, Tbilisi, USSR). Sov. Phys.-Solid State (Engl. Transl.), 9: 301-4(Aug. 1967).

Translated from Fiz. Tverd. Tela, 9: 394-9(Feb. 1967).

Cherenkov radiation due to the interaction of a modulated beam with a transparent medium is considered. Calculations are shown for the spectral composition and intensity of the radiation in cases where the beam passes through a cylindrical channel or a slit between two plane-parallel solid surfaces. (auth)

37132 GALILEAN INVARIANCE OF SUPPLEMENTED LANDAU–ZENER FORMULA. Mordvinov, Yu. P. Opt. Spectrosc. (USSR)(Engl. Transl.), 22: 291-2(Apr. 1967).

Translated from Opt. Spektrosk., 22: 529-31(Apr. 1967).

The transition of an electron in a collision between two atoms, in the adiabatic approximation, is considered when there is pseudo intersection of two electron energy levels. The relative velocity of the atomic nuclei is assumed to be so small that the adiabatic approximation is applicable. The atomic nuclei are assumed to move uniformly and in straight lines. (M.O.W.)

37133 INELASTIC SCATTERING OF 0.2 TO 0.8-keV ELECTRONS INCIDENT AT LARGE ANGLES ON BERYLLIUM AND LEAD. Bronshtein, I. M.; Dolinin, V. A. (Gertsen State Pedagogical Inst., Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 9: 535-6(Aug. 1967).

Translated from Fiz. Tverd. Tela, 9: 683-4(Feb. 1967).

A study of inelastic electron scattering in Be and Pb at angles of incidence $\vartheta = 60$ to 89° showed nonuniform behavior of the inelastic reflection coefficient (IRC) $\gamma = \eta_\vartheta \eta_0$ in both elements. The nonuniformities are demonstrated in curves showing η and γ as functions of electron energy. Contrary to the usual assumption it was found that $\gamma_{Be} > \gamma_{Pb}$ only when $E_p > 0.3$ keV. (A.G.W.)

37134 CYCLOTRON RESONANCE IN GASES. I. ATOMS AND NONPOLAR MOLECULES. Tice, Russell; Kivelson, Daniel (Univ. of California, Los Angeles). J. Chem. Phys., 46: 4743-7(June 15, 1967).

The cross sections for the scattering of very low-energy electrons, i.e., room-temperature electrons, from N_2 molecules have been measured as a function of electron velocity. The cross sections were determined by analyzing the widths and shapes of the cyclotron resonance absorption lines for electrons in an active nitrogen atmosphere. The electron-scattering cross sections for He, H_2, D_2, Ar, CH_4, CD_4, and CF_4 have also been determined by analyzing the cyclotron resonance linewidths and shapes for electrons in a gaseous mixture of N_2 and the other gas studied. The results agree reasonably well with those obtained by different techniques by other workers. No isotope effects were observed. (auth)

37135 ATOM TRANSFER IN ENDOTHERMIC ION–MOLECULE REACTIONS. Maier II, William B. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 46: 4991-2(June 15, 1967). (LA-DC-8545).

The measured cross section for the endothermic reaction $C^+ + D_2 \rightarrow CD^+ + D$ is shown as a function of the barycentric energy of the reactants from threshold up to 2.5 eV. The experimental cross section has a maximum value of roughly 2.7×10^{-16} cm² and reaches 80% of the maximum at approximately 0.6 eV above the apparent threshold energy. The results agree within experimental error with theoretical predictions. (A.G.W.)

37136 CALCULATED SPECTRUM OF QUASIBOUND STATES FOR $H_2(^1SIGMA/sub\ g/^+)$ AND RESONANCES IN H + H SCATTERING. Waech, Theodore G.; Bernstein, Richard B. (Univ. of Wisconsin, Madison). J. Chem. Phys., 46: 4905-11(June 15, 1967).

Deuterium isotope effects in the ionization of polyatomic gases by a collimated beam of alpha particles were investigated in acetylene, ethane, ethylene, hydrogen, and methane gases. Results are compared with data previously obtained by beta particles. For the 3 hydrocarbon gases, the increase in ionization for the deuterated over the normal was more than double the beta-particle ratio. No explanation is offered for such a marked increase. Hydrogen ratios were within experimental agreement. A further experiment was carried out with γ-irradiated hydrogen to determine the isotope ratio for beta particles of much higher initial energy than either tritium or ^{63}Ni. It was noted that, in marked contrast to the hydrocarbon gases, the ratio D_2/H_2 remains constant for the three modes of irradiation. (P.C.S.)

37137 RAPID CALCULATION OF ELECTRON SCATTERING FACTORS. Peacher, Jerry L.; Wills, John G. (Indiana Univ., Bloomington). J. Chem. Phys., 46: 4809-14(June 15, 1967).

The phase amplitude method is used to reduce the radial Schrödinger equation to two separate differential equations, one for the phase and one for the amplitude. These functions are both smooth as opposed to the rapidly oscillating solution of the radial Schrödinger equation for electron energies in the kilovolt range. The partial-wave phase shifts were obtained rapidly by integrating the differential equations for the phase and amplitude numerically. Hartree–Fock and Thomas–Dirac fields were used in the calculation. Results for argon and uranium are given in order to compare with previous results. It was found that the WKBJ approximation to the partial-wave phase shift is a good approximation for the energies used in electron diffraction. This rapid method of computing electron-scattering factors will make routine analysis of electron diffraction data more rapid as well as more exact. (auth)

37138 ORBIT–ORBIT INTERACTION IN MANY-ELECTRON ATOMS. Fraga, Serafin (Univ. of Alberta, Edmonton). J. Chem. Phys., 46: 4754-7(June 15, 1967).

The formulation of Wybourne and Jucys and co-workers has been used for the evaluation of the orbit–orbit interaction (for p^n configurations) and the corresponding parameters α, β, and δ (for d^n configurations). Values are presented for positive ions, neutral atoms, and negative ions, and for a number of isoelectronic series. (auth)

37139 CYCLOTRON RESONANCE IN GASES. II. CROSS SECTIONS FOR DIPOLAR GASES AND FOR CO_2. Tice, Russell; Kivelson, Daniel (Univ. of California, Los Angeles). J. Chem. Phys., 46: 4748-54(June 15, 1967).

The interaction of dipolar molecules with very low-energy electrons arises almost entirely from the monopole–dipole interaction. These cross sections have been measured by analyzing the widths and shapes of the cyclotron-resonance absorption lines of electrons in a gaseous mixture of N_2 and dipolar gases. The electron collision cross sections σ_D for the dipolar molecules could be reasonably well fitted to the relation $\sigma_D = 180D^2(v_0/v)^2$, where σ_D is in square angstroms, D is the dipole moment in Debye units, v is the electron velocity, and v_0 is the electron velocity of 298°K electrons (1.16×10^7 cm/sec). A Born-approximation calculation yields the same result with the coefficient equal to 130 rather than 180. CO_2 has an anomalously large cross section for a nonpolar molecule. The experimental data are compatible with a cross section that is proportional to v^{-1}, but can also be fitted by a dipolar cross section with D = 0.67, which is set equal to zero for $v < 5 \times 10^6$ cm/sec. This model corresponds to the physical situation in which the faster electrons seek the instantaneous dipole moment due to bending motions in CO_2, and the slower electrons feel the interaction over several vibrational periods and hence do not see a net dipole moment. However, estimates based on infrared data indicate that the effective dipole moment should only be about D = 0.16 in the ground state. The cross section of N_2O also shows evidence of being effected by instantaneous dipole moments. (auth)

37140 EXPERIMENTAL INVESTIGATIONS OF ION–MOLECULE REACTIONS OF D_3^+ WITH D_2 AND H_2. Doverspike, L. D.; Champion, R. L. (Univ. of Florida, Gainesville). J. Chem. Phys., 46: 4718-25(June 15, 1967).

The reactions $D_3^+ + D_2 \rightarrow D_3^+ + D$ and $D_3^+ + H_2 \rightarrow (D_2H^+, H_2D^+) + (H, D)$ have been studied using an angular ion-scattering apparatus in which the kinetic-energy distributions of the various product ions have been measured for collision energies in the range 2 to 15 eV. The angular distributions of the D_3^+ and D_2H^+ product ions have also been determined, at primary beam energies in the interval 7 to 11 eV. The observed product-ion kinetic-energy distributions show that several endothermic reaction channels exist for these reactions. The most probable channels for D_3^+ and D_2H^+ formation are those in which the product ions are formed by a pickup process, in which very little momentum is transferred to the H or D atom. By comparing the results of these isotopic reactions, it is inferred that D_3^+ is formed not only by D atom transfer to D_3^+, but also by D^+ ion transfer to the target D_2 molecule. Further-

more, at low collision energies, reaction channels corresponding to completely inelastic reactions in which all the center-of-mass collision energy appears as excitation energy of the product ions were observed for all three product ions. (auth)

37141 MOLECULAR RESONANT CHARGE-TRANSFER PROCESSES: $H_2^+-H_2$ AND $N_2^+-N_2$. Leventhal, J. J.; Moran, T. F.; Friedman, F. (Brookhaven National Lab., New York). J. Chem. Phys., 46: 4666-72(June 15, 1967). (BNL-10828).

A study has been made of the competition between exothermic ion-molecule reactions and resonant charge-transfer processes in collisions of diatomic molecule ions and their parent molecules: $H_2^+-H_2$ and $N_2^+-N_2$. Experimental values of resonant charge-transfer cross sections are shown to be smaller than values obtained from calculations using an impact parameter method. Much better agreement between experiment and theory is obtained if competition between ion-molecule reaction and charge transfer is assumed and experimental values of both channels of reaction are summed prior to comparison with theory. The mechanisms of the respective processes are illuminated by an examination of the velocity dependences of charge-transfer cross section for both diatomic systems. With $H_2^+-H_2$ where reaction producing H_3^+ is a probable process, in low-velocity collisions, the velocity dependence of charge transfer is essentially that of collisions of ions with unperturbed rectilinear trajectories. In a similar low-energy region, $N_2^+-N_2$ is not energetically capable of participating in ion-molecule reactions and the velocity dependence of charge-transfer cross section is steeper, characteristic of both orbiting collisions and the larger-impact-parameter rectilinear trajectory collisions. Experimental cross sections for charge transfer and ion or atom transfer reflect probability of reaction but their velocity dependences clearly isolate the range of impact parameters operative for the respective processes. (auth)

37142 SELECTIVE ENHANCEMENT IN HYDROGENLIKE MOLECULES WITH THE RARE GASES. II. HD AND D_2 WITH Ar AND Kr. Takezawa, S.; Innes, F. R.; Tanaka, Y. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Chem. Phys., 46: 4555-61(June 15, 1967).

Recent work on selective enhancement of the H_2 spectrum in Ar and Kr discharges has been extended to HD and D_2. Similar phenomena are expected and can be observed in the spectra of these molecules when excited in Ar but not in Kr. The explanation given of the processes involved in the case of H_2, namely, resonance fluorescence and collisions of the second kind involving allowed transitions, was supported also by the observed evidence in the present work. Vibration levels in the ground state of HD and D_2 were greatly extended and the highest levels that occur in these states can now be estimated at (v =) 17 and 21, respectively. (auth)

37143 LONG-RANGE FIRST-ORDER INTERACTION ENERGY BETWEEN TWO EXCITED HYDROGEN ATOMS IN EITHER 2s OR 2p STATES. Kim, Hojing; Hirschfelder, Joseph O. (Univ. of Wisconsin, Madison). J. Chem. Phys., 46: 4553-4(June 15, 1967).

The long-range interactions between two hydrogen atoms in either 2s or 2p states yields the first-order perturbation energy matrix that is still nondiagonal even after the symmetry adaptation of the zero-order degenerate functions. In the diagonalization process of the nondiagonal blocks, it is found that the familiar series expansion of the interaction potential energy in inverse powers of the internuclear separation is not practicable even up to 60 Bohr units. (auth)

37144 NONLINEAR CALCULATION OF THE DYNAMIC POLARIZABILITY AND LONG-RANGE INTERACTION OF H. Sitz, Paul; Yaris, Robert (Washington Univ., St. Louis). J. Chem. Phys., 46: 4994-5(June 15, 1967).

A minimum-variational method utilizing a nonlinear trial wave function was employed to calculate the dynamic polarizability and long-range interaction constant for hydrogen atoms. The results are in essential agreement with experiment and with other calculations and indicate that the method should be useful for more complicated systems. (A.G.W.)

37145 EFFECT OF THE MAGNETIC FIELD ON MUON POLARIZATION. Tammet, E. (Inst. of Cybernetics, Tallin). Izv. Akad. Nauk Est. SSR, Fiz. Mat., 16: 135-8(1967). (In Russian).

The effect of the external magnetic field on muon polarization, taking into consideration the interaction of the magnetic moments of the muon and nucleus responsible for the hyperfine structure of mesic atoms, was studied. Using analogical solution, the effect of the external magnetic field on polarization of the muon, taking into consideration the interaction of the magnetic moment of the muon with the magnetic field of the electron shell, was found. (auth)

37146 ENERGY LEVELS FOR AN EXTENDED THOMAS-FERMI-DIRAC POTENTIAL. Yonei, Katsumi (Okayama Univ., Japan). J. Phys. Soc. Jap., 22: 1127-32(May 1967).

One-electron energy levels (occupied and excited) of K and Cs are calculated by solving the Schroedinger equation with a given potential determined on the basis of the extended statistical theory discussed in a previous paper. In order to make a quantitative examination of the obtained wave functions, the dipole matrix elements are also computed. The present calculation clearly shows that the extended statistical theory with a modified Weizsäcker correction has advantages over the simple Thomas-Fermi-Dirac theory. (auth)

37147 REDUCTION FOR ANOMALOUS DISPERSION IN THE THEORY OF ABSORPTION LINE FORMATION IN A MAGNETIC FIELD. Rachkovskii, D. N. Izv. Krym. Astrofiz. Observ., 37: 56-61(1967). (In Russian).

The formation of absorption lines with an anomalous Zeeman effect in a semifinite atmosphere with a uniform magnetic field is considered. A constant ratio of the absorption coefficient in a line to the absorption in the continuous spectrum is assumed and a linear dependence of the source function on optical depth adopted. Purely coherent radiative scattering in a line with frequency is taken into account and also the terms corresponding to anomalous dispersion in the absorption matrix. It is shown that the solution of the problem is reduced to the solution of a system of equations, which is a generalization of the integral equation for the Ambartsumian φ function. The system of integral equations can easily be solved numerically by the method of successive approximations using an electron computer. (auth)

37148 LOGARITHMIC TERMS IN THE WAVE FUNCTIONS OF THE 2^1S AND 2^3S STATES OF TWO-ELECTRON ATOMS. Frankowski, K. (Univ. of Minnesota, Minneapolis). Phys. Rev., 160: 1-3(Aug. 5, 1967).

Following a previous attempt to analyze the convergence rate of variational calculations for the ground state of two-electron atoms, the nonconventional terms $\ln(r_1 + r_2)$ and $[\ln(r_1 + r_2)]^2$ were inserted into the 2^1S and 2^3S states, with the proper exponentials. The convergence of the energy eigenvalues seems to indicate that logarithmic terms are important in these states also. (auth)

37149 GROUND STATE OF LIQUID ^{4}He AND ^{3}He. Schiff, Daniel (New York Univ.); Verlet, Loup. Phys. Rev., 160: 208-18(Aug. 5, 1967).

A variational calculation of the ground-state energy of liquid helium-3 and liquid helium-4 is made using, respectively, Jastrow- and Slater-Jastrow-type trial wave functions. In the boson (^{4}He) case, the quantum average, analogous to a statistical average over a fictitious canonical ensemble, is computed by a molecular-dynamics method for a system of 864 atoms. The following quantities are obtained: ground-state energy: -5.95°K/atom (experiment: -7.14°K/atom); equilibrium density (0.020 ± 0.002) atoms/Å^3 (experiment: 0.022 atoms/Å^3); liquid-structure factor; fraction of particles condensed in the zero-momentum state: 0.105 ± 0.005. This is in good agreement with previous computations. In the fermion (^{3}He) case, the energy expectation value is calculated approximately by use, up to second order, of a cluster expansion of the effect of the antisymmetrization, developed by Wu and Feenberg. The ground-state energy obtained is -1.35°K/atom (experiment: -2.52°K/atom). The liquid-structure factor of liquid ^{3}He, for which no experimental result is yet available, is calculated in this approximation. (auth)

37150 EXCITATION OF ATOMIC HYDROGEN BY PROTONS. Cheshire, Ian M.; Sullivan, Edward C. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 160: 4-8(Aug. 5, 1967).

Excitation cross sections for protons incident on atomic hydrogen are calculated by a nonadiabatic method. This consists of expanding the wave function in the spherical harmonics of the target, giving rise to an infinite set of coupled two-dimensional equations. These are solved numerically in the approximation which retains only S and P states of the target. (auth)

37151 CONTACT MAGNETIC-DIPOLE HYPERFINE STRUCTURE IN $3d^N 4s^2$ ATOMS. Childs, W. J. (Argonne National Lab., Ill.). Phys. Rev., 160: 9-10(Aug. 5, 1967).

The experimental value of $a(s)/\gamma$, where $a(s)$ is the contact part of the magnetic-dipole hyperfine interaction and $\gamma = \mu_I/I$, is considered as a function of the number N of 3d electrons present. The effects of intermediate coupling and configuration interaction (including core polarization) are allowed for wherever possible in the extraction of $a(s)$ from the available experimental data. The resulting curve, which should more accurately describe the variation of the contact hfs with N, is considerably smoother than when these refinements are omitted. New experimental results for ^{61}Ni are included. (auth)

37152 SPIN-EXCHANGE SCATTERING IN UNIFORM MAGNETIC FIELDS. Glassgold, A. E.; Walker, James F. (New York Univ.). Phys. Rev., 160: 11-16(Aug. 5, 1967).

The role of a uniform magnetic field in the collision of two one-electron atoms is analyzed using previously developed density-matrix techniques. During the collision, all magnetic-moment interactions are small compared to the usual singlet and triplet potentials, and the only effect of the magnetic field is to alter the asymptotic states. This effect may be described in terms of the unitary transformation which diagonalizes the Breit–Rabi Hamiltonian. The properties of this transformation are given in detail for electronic spin $\frac{1}{2}$ and arbitary nuclear spin. In addition to presenting a general formulation for this scattering problem, explicit formulas are given for spin exchange in the scattering of polarized beams from unpolarized targets. (auth)

37153 LARGE-Z EXPANSION THEORY FOR THE GROUND STATE OF A ONE-ELECTRON ION PERTURBED BY r^N. Mendelsohn, Lawrence B. (Polytechnic Inst. of Brooklyn). Phys. Rev., 160: 16-20(Aug. 5, 1967).

Large-Z (nuclear charge) expansion theory is applied to the nonrelativistic ground state of a one-electron ion which is perturbed by a repulsive central field potential which goes as the Nth power of the radial distance of the electron from the nucleus where N is an integer ($N = -1$; $N \geq 1$). The energy-expansion parameters for these problems are determined self-consistently within the asymptotic method itself. General recursive relations for the wave-function expansion coefficients in the basic asymptotic expansion and the stretched solution are obtained. For the case of $N = 1$, the wave function and the energy expansion are obtained explicitly through third order. For $N = -1$, the basic asymptotic solution is the exact solution. For r large, a few terms of the conventional large-Z perturbation-theory expansion for the $N = -1$ case give an inaccurate representation for the exact wave function. The relative error associated with first-order perturbation-theory expectation-value results is shown to increase as the operator probes the outer part of the atom to a greater extent. (auth)

37154 OPTICAL IONIZATION–EXCITATION FUNCTIONS OF HELIUM BY ELECTRON IMPACT. Anderson, Richard J.; Lee, Edward T. P.; Lin, Chun C. (Univ. of Oklahoma, Norman). Phys. Rev., 160: 20-2(Aug. 5, 1967).

The cross sections for the production of the 3203 Å ($n = 5 \rightarrow 3$), 2733 Å ($n = 6 \rightarrow 3$), 2511 Å ($n = 7 \rightarrow 3$) lines of He^+ by ionization–excitation collisions between electrons and neutral atoms have been measured over the energy range of 0 to 350 eV. All three excitation functions have their maximum values near 230 eV and show the same general shape as that of the 4686 Å ($n = 4 \rightarrow 3$) line. The Born approximation was used to compute the direct ionization–excitation cross sections of the nS, nP, and nD states of the He^+ ions (n = 5, 6, and 7) from which the theoretical excitation cross sections of the 3203, 2733, and 2511 Å lines are obtained. In all cases the $nS \rightarrow 3P$ transition accounts for 90% of the total radiation of the $n \rightarrow 3$ transitions. The theoretical ionization–excitation cross sections are found to exhibit reasonable agreement with the experimental values. The cascade contributions of the observed intensities of the three lines are estimated to be less than 5%. (auth)

37155 USE OF THE OPTICAL POTENTIAL FOR ELASTIC SCATTERING OF ELECTRONS BY ATOMS. Kelly, Hugh P. (Univ. of Virginia, Charlottesville). Contract AT(40-1)-2915. Phys. Rev., 160: 44-52(Aug. 5, 1967). (ORO–2915-70).

The use of optical potential for elastic scattering of electrons by atoms is examined. The optical potential is related to the self-energy of the single-particle Green's function and is represented by a perturbation expansion. The optical potential is applied to the elastic triplet-state scattering of S-wave electrons from hydrogen. The Hartree–Fock potential is used to calculate the single-particle states of the perturbation expansion. It is found that the second-order optical-potential terms calculated with the Hartree–Fock potential are not sufficient to give good agreement with accurate results obtained by the variational calculations of Schwartz. The higher-order terms for the optical potential are evaluated by methods used in previous atomic many-body calculations, and good agreement with the variational results is then obtained. (auth)

37156 ROTATIONAL EXCITATION OF DIATOMIC MOLECULES BY SLOW ELECTRONS: APPLICATION TO H_2. Lane, Neal F.; Geltman, S. (Univ. of Colorado, Boulder. National Bureau of Standards, Boulder, Colo.). Phys. Rev., 160: 53-67 (Aug. 5, 1967).

The theory of electron scattering from a rigid rotator is applied to the case of low-energy scattering of electrons from hydrogen molecules in ground electronic and vibrational states. The coupled equations are solved numerically and the resulting S matrix is used to calculate elastic, rotational excitation, and rotational de-excitation cross sections. The electron–molecule interaction potential is based on the approximate charge distribution of H_2 and includes the effects of polarization, which are shown to be important. Cross sections are given for several rotational states, and it is pointed out that while the elastic and inelastic cross sections are found to depend on the initial rotational angular momentum j of the molecule, their variation in j is such that the total cross section remains independent of j. The effects of "back coupling" and coupling with higher rotational states are illustrated by comparing the results of the close-coupling calculation with those of the Born and distorted-wave methods; the distorted-wave and close-coupling results for rotational excitation are found to agree within 20% for all energies. (auth)

37157 COLLISION-INDUCED MIXING IN THE 2^3P LEVELS OF HELIUM. Schearer, L. D. (Texas Instruments Inc., Dallas). Phys. Rev., 160: 76-80(Aug. 5, 1967).

The cross section for the transfer of excitation from the 2^3P_0 level of helium to the 2^3P_1 and 2^3P_2 levels as a result of collisions with the ground-state helium atom (1^1S_0) has been measured with a conventional resonance-fluorescence technique. A ^4He source excited the $2^3S_1 - 2^3P_0$ transition in a ^3He absorption cell. The scattered light was examined with a high-resolution grating spectrometer and the ratio of the $2^3P_0 \rightarrow 2^3S_1$ to the $2^3P_{1,2} \rightarrow 2^3S_1$ intensities was measured as a function of cell pressure from 0.05 to 10 Torr. The cross section for collision-induced transitions out of the 2^3P_0 level is found to be $(68 \pm 3) \times 10^{-16}$ cm^2 at room temperature. (auth)

37158 ELECTRON-DETACHMENT IN SLOW COLLISIONS BETWEEN ATOMS AND NEGATIVE IONS. Herzenberg, A. (Westinghouse Research Labs., Pittsburgh). Phys. Rev., 160: 80-94(Aug. 5, 1967).

The collision of a negative ion A^- and neutral atom B at a very low kinetic energy (a few eV or less) may lead to the release of an electron through the reaction $A^- + B \rightarrow (AB) + e$, known as "associative detachment." At higher energies, $A^- + B \rightarrow A + B + e$ also becomes possible. A theory of these processes is formulated by assuming that the electronic state is stable at large separations R of A^- and B, and changes adiabatically as R decreases; at very small R, of the order of 10^{-8} cm, the electronic state turns into an unstable compound state able to emit an electron. Expressions are derived for the total cross section for electron detachment, and for the cross sections for detachment leaving the nuclei in a single discrete final state. At thermal energies, the total cross section can become very large because of Langevin spiralling, arising from the long-range polarization between A^- and B. For example, in the reaction $H^- + H \rightarrow H_2 + e$, the cross section is estimated to be of the order of 10^{-14} cm^2 at a relative kinetic energy of k × 400°K. (auth)

37159 EXCITATION OF HELIUM BY ELECTRONS AND PROTONS. Vriens, L. (Univ., Utrecht). Phys. Rev., 160: 100-8 (Aug. 5, 1967).

Generalized oscillator strengths f(K) are discussed. On the basis of previous work of Lassettre, a suitable form for the power-series representations of the f(K) for transitions in which an electron jumps from a 1s to an ns, np, or nd orbital of an atom is obtained. The method is applied to give analytical representations of f(K) for the transitions $1^1S \rightarrow 2^1P$ and $1^1S \rightarrow 3^1P$ in helium. The dependence of the "total" excitation cross sections σ_E on the velocity v of the incident electron or proton for various dipole-allowed and dipole-forbidden transitions was examined. By expanding the theoretical σ_E (direct and interference) in a series in inverse powers of v^2, a qualitative interpretation was found of the variation with v of the experimental σ_E of Moustafa and de Heer (electrons) and of Van den Bos, Winter, and de Heer (protons) for the transitions $1^1S \rightarrow n^1S$, n^1P, and n^1D in helium, with n = 3, 4, 5, and 6. From the analytical formula for f(K) in the transitions $1^1S \rightarrow 2^1P$, 3^1P in helium, the corresponding σ_E were calculated, and these values were compared with some other theoretical and experimental ones. The influence of interference between direct and exchange scattering is taken into account by using the Ochkur approximation. It is shown that the Ochkur approximation can be obtained in a simple way from the Bethe and Mott formulas. The nature of f(K), for complex K, and for ionization of atoms were studied and the positions of the singularities (poles) were found. (auth)

37160 SCATTERING OF ELECTRONS FROM H_2^+: THE METHOD OF POLARIZED SINGLE-CENTER ORBITALS. Temkin, A.; Vasavada, Kashyap V. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 160: 109-17(Aug. 5, 1967).

A generalization of the method of polarized orbitals is introduced to calculate the scattering of electrons from diatomic molecules in the Born–Oppenheimer (fixed-nuclei) approximation. The molecule is described by a single-center expansion which in lowest order is

spherically symmetric and therefore an atomic-like function. This function can be polarized in complete analogy with an atomic orbital. Furthermore, the first approximation beyond the spherically symmetric can be included to give a permanent distortion correction. In the s-wave results, the induced polarization effects are larger than the first-order correction. The p-wave phase shifts are in some cases much larger than the s wave, and very complicated by virtue of the combined effects of exchange, polarization, and first permanent distortion. The method also yields, as a by-product of the polarizability of H_2^+. A general analysis is given of the partial-wave expansion from diatomic molecules in the Born–Oppenheimer approximation. The scattered amplitude is given in terms of phase shifts which are independent of the angles between the internuclear axis and the incident direction. The dependence on these angles is shown to be factorable and analytically expressible independent of the dynamical problem. (auth)

37161 THEORY OF HIGH-ENERGY INELASTIC COLLISIONS BETWEEN MOLECULAR SYSTEMS. DISSOCIATION OF H_2^+ ON COLLISION WITH H_2. Peek, James M. (Sandia Lab., Albuquerque, N. Mex.); Green, Thomas A.; Weihofen, W. H. Phys. Rev., 160: 117-24(Aug. 5, 1967).

Inelastic collisions between the hydrogen molecule ion (H_2^+) and the hydrogen molecule are investigated theoretically within the framework of the first Born approximation. The possibility that H_2^+ may be in an excited vibrational state before the collision takes place is given special consideration. Appropriate sums of the theoretical cross sections are identified with the experimental measurements of the cross section σ_1, for the dissociation of H_2^+ into a proton and hydrogen atom, and of $\sigma_1 + \sigma_2$, where σ_2 is the ionization cross section of H_2^+. Agreement is good between theory and σ_1 for collision energies greater than 50 keV and between theory and $\sigma_1 + \sigma_2$ for collision energies greater than 1 MeV. Any discrepancies between experiment and theory can be identified as either the expected failure of the Born approximation at low energies or the omission of certain inelastic processes in the theoretical results. (auth)

37162 EQUIVALENCE OF THE SUDDEN APPROXIMATION TO THE HIGH-ENERGY LIMIT OF THE FIRST BORN APPROXIMATION. Peek, James M. (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 160: 124-9(Aug. 5, 1967).

The ratio of total cross sections for two different inelastic events in a given target as predicted by the sudden approximation is shown to be equal to the high-energy limit of the corresponding first Born approximation to the ratio. This relationship between the two theories is established for the special cases of the ratio of single to double ionization of helium atoms by electrons and by hydrogen atoms. The electron–helium-atom ratio is found to be the same as the hydrogen-atom–helium-atom ratio. The proof supposes that the same approximate wave functions were used in both theories and that the dominant term in the high-energy expansion of the first Born total cross section is independent of energy-conservation requirements. This latter point is established for a general ionization event. (auth)

37163 RELATIVISTIC SELF-CONSISTENT FIELDS WITH EXCHANGE. Smith, F. C.; Johnson, W. R. (Univ. of Notre Dame, Ind.). Contract AT(11-1)-427. Phys. Rev., 160: 136-42 (Aug. 5, 1967). (COO-427-66).

A relativistic Hartree–Fock calculation of atomic wave functions and energy levels is carried out. The relativistic Hamiltonian is the sum of the Dirac Hamiltonian of the electrons and the retarded Breit interaction. Expressions for the matrix elements of the Hamiltonian are given for closed-shell configurations of electrons, and the relativistic Hartree–Fock equations are derived. A numerical program to compute the Dirac radial functions and energy eigenvalues for an arbitrary closed-shell atom is described. Results obtained for the energies of the ground states of He and Be are found to be in precise agreement with previous nonrelativistic calculations. Results for Ne, Ar, and Cu^+ are also presented and compared with previous self-consistent-field calculations. (auth)

37164 APPLICATION OF THE FOCK EXPANSION TO DOUBLY EXCITED STATES OF THE HELIUM ATOM. Macek, J. H. (National Bureau of Standards, Washington, D. C.). Phys. Rev., 160: 170-4(Aug. 5, 1967).

The formal properties of the Fock expansion of helium-atom wave functions provide a frame within which the behavior of doubly excited ^1P states can be simply expressed. The convergence of the expansion is investigated. (auth)

37165 QUADRUPOLE ANTISHIELDING FACTORS OF IONS. Sternheimer, R. M. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Phys. Rev., 159: 266-72(July 10, 1967). (BNL-10867).

Values of the quadrupole antishielding factor γ_∞ were obtained for the following ions: Y^{3+}, In^{3+}, Bi^{3+}, and Am^{3+}, using the method of direct solution of the inhomogeneous Schroedinger equation for the perturbed wave functions. The wave functions $v_1'(nd \rightarrow s)$ and the resulting terms $\gamma_\infty(nd \rightarrow s)$ have been calculated for the case of $Cu^+3d \rightarrow s$, $Ag^+4d \rightarrow s$, and $Bi^{3+}5d \rightarrow s$. The hexadecapole antishielding factor η_∞ for the In^{3+} ion was also obtained. Values of the lattice sums for $\partial^4V/\partial z^4$ pertaining to the nuclear hexadecapole interaction (V = crystal potential) were determined for the following types of cubic lattice: simple cubic, NaCl structure, body-centered-cubic, and face-centered-cubic. (auth)

37166 USE OF GENERAL THEORY OF NUCLEAR REACTIONS FOR CALCULATIONS OF ATOMIC COLLISIONS. Khalikova, D. Kh. Uch. Zap. Ul'yanovsk. Gos. Pedagog. Inst., 18: No. 5, 59-61(1964). (In Russian).

The general theory of nuclear reactions is applied to an analysis of atom–atom and atom–ion collisions. The effective cross section (σ) of inelastic scattering of H_2 and H_2^+ is determined without allowance for Coulomb interaction. It is found that to determine σ it is necessary to take into account 15 partial waves. The value of σ coincides in order of magnitude with the known results. (ATD)

37167 OBSERVATION OF A v x E EFFECT IN AN ELECTRIC DIPOLE MOMENT EXPERIMENT USING A REVERSIBLE ATOMIC BEAM MACHINE. Angel, J. R. P.; Sandars, P. G. H.; Tinker, M. H. (Oxford Univ.). Phys. Lett., 25A: 160-1 (July 31, 1967).

A reversible atomic beam machine was used to eliminate the $v \times E$ effect and set a new limit $d_e \leq 1 \times 10^{-22}$ e/cm on the electric dipole moment of the electron. (auth)

37168 TRANSVERSE HEAT TRANSPORT IN POLYATOMIC GASES UNDER INFLUENCE OF A MAGNETIC FIELD. Hermans, L. J. F.; Fortuin, P. H.; Knaap, H. F. P.; Beenakker, J. J. M. (Kamerlingh Onnes Laboratorium, Leiden). Phys. Lett., 25A: 81-2(July 31, 1967).

Transverse heat flow occurring in a gas of polyatomic molecules under influence of a magnetic field was measured for N_2, CO, O_2, HD, CH_4, and CD_4 at 77.4°K, and for NO and CF_4 at 81°K. The experimental results are in fair agreement with theory. Signs of rotational Landé g factors were determined. (auth)

37169 EFFECT OF HYDROSTATIC PRESSURE ON THE FERMI SURFACE OF Be. O'Sullivan, W. J.; Schirber, J. E. (Sandia Lab., Albuquerque, N. Mex.). Phys. Lett., 25A: 124-5 (July 31, 1967).

The effect of hydrostatic pressure on the Fermi surface of Be was determined using both solid and fluid He techniques. A comparison is made with the results of recent studies of the oscillatory magnetostriction. (auth)

37170 HELIUM STATES. I. NOVEL WAVE FUNCTIONS FOR SINGLY EXCITED ^1S STATES. Schrader, David M. (Univ. of Iowa, Iowa City). Theor. Chim. Acta, 7: 97-102(1967).

Wave functions for the 2^1S, 3^1S, and 4^1S states of He were calculated using as trial wave functions screened hydrogenic orbitals that have the coordinates $r_<$ and $r_>$ as arguments. Direct minimization of the energy expression for each state, without assuming orthogonality to any lower state, gave reasonable results. In the case of the 2^1S state and no other, the energy as a function of the variational parameters exhibited 2 minima, the deeper of which was shown by overlap considerations to correspond to the ground state. The present results were compared to those obtained with the Eckart-type screened hydrogenic wave functions. (BBB)

37171 THEORY OF IONIZATION OF ATOMIC HYDROGEN BY ELECTRON IMPACT AND THRESHOLD LAW. Kang, Ik-ju; Foland, W. D. (Univ. of Massachusetts, Amherst). Phys. Lett., 25A: 11-12(July 17, 1967).

Ionization of hydrogen atoms by electron impact is treated by employing the time-independent Green's function method in such a way that the interaction energy of the two electrons is the only perturbation. The nearly linear threshold law is obtained. (auth)

37172 PERTURBATION THEORY WITH HARTREE–FOCK STATES. Kelly, H. P. (Univ. of Virginia, Charlottesville). Contract AT(40-1)-2915. Phys. Lett., 25A: 6-7(July 17, 1967). (ORO-2915-77).

The use of Hartree–Fock states for perturbation calculations is discussed. An approximate method for summing hole–particle interactions is given. (auth)

37173 OSCILLATOR STRENGTHS IN ISOELECTRONIC SEQUENCES. Hefferlin, Ray; Rascon, Lucy (Southern Missionary Coll., Collegedale, Tenn.). J. Opt. Soc. Amer., 57: 964-6(July 1967).

Conclusions were drawn from a study of 58 graphs of the f value for a given transition as a function of charge number in an iso-

electronic sequence. From these conclusions it is conjectured that two values in a previous work and its source material are incorrect. (M.H.R.)

37174 SPECTRAL-LINE PROFILES FOR A FAST-ION-BEAM SOURCE. Marquet, L. C. (Univ. of Arizona, Tucson). J. Opt. Soc. Amer., 57: 878-80(July 1967).

When fast, foil-excited ions are used as a light source, the resulting spectral lines are Doppler-broadened because the radiating particles are moving and the spectrograph has a finite acceptance angle. An exact expression has been obtained for the line profile produced by a stigmatic spectrograph without vignetting. For $\beta^2 \ll 1$, the irradiance is $I(\lambda) \sim \{\frac{1}{4}\theta^2 - [(\lambda_0 - \lambda)/\beta\lambda_0]^2\}^{\frac{1}{2}}$ when the square root is real, and zero otherwise. Theta is the spectrograph's acceptance angle. The line width at half maximum is $\Delta\lambda \sim 0.866\theta\beta\lambda_0$. Vignetting causes the line shape to deviate from the theoretical profile. For a Meinel-type spectrograph, this effect can give doubled line images. (auth)

37175 IONIZATION POTENTIALS OF ATOMS AND IONS FROM HYDROGEN TO ZINC. Lotz, Wolfgang (Institut fuer Plasmaphysik, Munich). J. Opt. Soc. Amer., 57: 873-8(July 1967).

A complete set of ionization potentials of all ionization stages is given for the elements hydrogen through zinc (Z = 30). The ionization potentials are calculated along isoelectronic sequences with full regard to experimental values in the sense that experimental values are preferred in all cases of doubt. Along sequences that are well established experimentally the difference to the next higher species is calculated by interpolation or extrapolation of the second differences and the third differences. Sequences that are not so well established experimentally are calculated by interpolation or extrapolation of the difference to the same ionization stage of one of the better-known sequences. Similarities in the periodic table are taken into account. (auth)

37176 MOMENTUM AND ENERGY OF GRAVITATIONAL WAVES. Shirokov, M. F.; Bud'kɔ, L. I. (Moscow Aviation Inst.). Dokl. Akad. Nauk SSSR, 172: 326-9(Jan. 11, 1967). (In Russian).

The integral laws of the conservation of momentum, energy, and mass in the general theory of relativity apply only to space–time regions with Galilean considerations of infinity. Further consideration of this problem reveals that localization of momentum–energy does not have a physical meaning but the energy–momentum integral vector of a purely gravitational field, obtained by solving the gravitational equation, has a specific meaning. Solution of the wave equation for a weak field was analyzed. Wave formations, designated as wave packets were obtained; their four-dimensional energy–momentum vector was equal to zero. Wave packets of gravitational waves are examined; they were similar to electromagnetic wave packets, occupying at a given time a finite portion of the space which does not contain charged or neutral particles of matter. They are designated as photons in electrodynamics and gravitrons in the theory of gravitation. (TTT)

37177 PHOTO-IONIZATION CROSS-SECTIONS OF CALCIUM VAPOR. Hudson, R. D.; Carter, Virginia L. (Aerospace Corp., El Segundo, Calif.). Astrophys. J., 149: 229-30(July 1967).

In an attempt to resolve the disagreement between Newsom (1966) and Ditchburn and Hudson (1960), and to place Newsom's results on an absolute scale, absolute cross sections were obtained for calcium vapor at an instrumental band width of 0.075 Å in the vicinity of the series limit and of the autoionization lines at 1885.9 and 1765.10 Å. (W.D.M.)

37178 THE ASSOCIATIVE DETACHMENT OF H AND H^-. Dalgarno, A.; Browne, J. C. (Queen's Univ. of Belfast). Astrophys. J., 149: 231-2(July 1967).

It was pointed out by Dalgarno (cf. Pagel 1959) that the rate coefficient k for the associative detachment reaction $H^- + H \rightarrow H_2 + e$ is probably of the order of $10^{-9.5}$ cm^3 sec^{-1} at solar photosphere temperatures T. Thus the frequency of associative detachment exceeds that of photodetachment for optical depths greater than about 10^{-3} and the dissociation equilibria of H^- and of H_2 are closely coupled. An alternative estimate for k of $1.2 \times 10^{-11} T^{\frac{1}{2}}$ has been made by McDowell (1961). Recent calculations of resonating states of H_2^- allow a more precise prediction of k. (W.D.M.)

37179 OSCILLATOR STRENGTH OF THE RESONANCE TRIPLET OF ATOMIC OXYGEN. Parkes, David A.; Keyser, Leon F.; Kaufman, Frederick (Univ. of Pittsburgh). Astrophys. J., 149: 217-23(July 1967).

The absorption oscillator strength of each of the three lines of the O I resonance triplet near 1300 Å was measured by the line-absorption method and found to be 0.021 ± 0.003. $\Sigma g_L f_{LU}$ is therefore 0.19 ± 0.03. The components of the ground state, O^3P, were found to be in thermal equilibrium. The results are compared with those of other experimental and theoretical studies. (auth)

37180 ANGULAR DISTRIBUTIONS FOR ELASTIC AND INELASTIC e–Hg SCATTERED AT LOW ENERGIES. Yeates, Clayne Monson. Provo, Utah, Brigham Young Univ., 1967. 88p. Thesis.

Angular distributions from 40° to 120° of the ratio of elastic to inelastic e–Hg scattering are measured for incident electron energies of 30, 15, 7, and 5 eV. The previous lower limit was 23 eV and no resolution of the 6^1P_1 and 6^3P_0 excitation cross sections had been achieved, hence the previous inelastic cross sections included all electrons with energy losses up to 7 volts. Resolution of these two levels is achieved, and the ratio of elastic to 6^3P_0 excitation is plotted as a function of electron energy and scattering angle. A theoretical solution is given for the problem of tandem optical pumping, to obtain the fraction of Hg I atoms in the triplet P metastable states. This fraction is determined as a function of the intensity of illumination, and of the leakage from the metastable states. An attempt was made to scatter electrons from the metastable atoms to determine the efficiency of optical pumping, and to measure the angular distribution of the superelastic cross section. Superelastic scattering is not observed; this is attributed to the ineffectiveness of filtering out the unwanted visible lines 5460 Å and 4047 Å, and to the weak intensity of the pumping lamps. (Disser. Abstr.)

37181 MANY-ELECTRON PROBLEM. Viswanathan, K. S. ASIA Monographs No. 7. New York, ASIA Publishing House, 1966. 252p. $5.75.

An account is given of the mathematical methods developed to treat systems containing a large number of electrons. The self-consistent field method, the Hartree–Fock equations, and correlation effects in atomic and molecular systems are covered. The correlation is continued in the last chapter, which treats the long-range Coulomb interactions of electrons in a metallic lattice, and the collective or plasma oscillations. The most accurate and recent calculations made with electronic digital computers for the hydrogen molecule and the helium-like ions are in the section on two-electron systems. There are two chapters dealing with relativistic corrections, second quantization, perturbation methods, and Green's functions. (M.H.R.)

37182 PHOTOIONIZATION PROCESSES IN GASES. Marr, Geoffrey V. Pure and Applied Physics. A Series of Monographs and Textbooks. Volume 28. New York, Academic Press, 1967. 293p. $12.50.

Collected experimental and theoretical data on the ionizing interaction of energetic protons with atoms and molecules are presented. Applications of this data to the fields of plasma physics, aeronomy, and astrophysics are given. Detailed references to original quantitative data are given, and absolute photoionization and autoionization cross section curves are collected for individual species of atoms and molecules. The material is presented in a form suitable for study by graduate students in physics and chemistry and research workers requiring a discussion of the development and status of this branch of quantitative spectroscopy. (W.D.M.)

Cosmic Radiation

Refer also to abstracts 36445, 36964, 36966, 36967, and 37728.

37183 (BNL–11544) SEARCH FOR PARTICLES WITH CHARGE 2/3e IN COSMIC RAYS. Kasha, H.; Larsen, R. C.; Leipuner, L. B. (Brookhaven National Lab., Upton, N. Y.); Adair, R. K. (Yake Univ., New Haven, Conn.). [1967]. 11p. (CONF-670628–2). Dep. CFSTI.

From 10th International Conference on Cosmic Rays, Calgary, Alberta, Canada.

The flux of particles with a charge equal to ⅔ of the electron charge which reach sea level from the vertical with relativistic velocities was found to be less than 2.7×10^{-10} $cm^{-2}sr^{-1}sec^{-1}$ at the 90% confidence level. The particles were identified through their characteristic energy loss in a 48-counter hodoscope. The result seems inconsistent with a model of hadrons as being a composite of quarks. (auth)

37184 (BNL–11545) MOMENTUM SPECTRUM AND CHARGE EXCESS OF COSMIC RAY MUONS AT LARGE ZENITH ANGLES. Kasha, Henry (Brookhaven National Lab., Upton, N. Y.); Hawkins, C. B. J.; Stefanski, J. R. (Yale Univ., New Haven, Conn.). [1966]. 10p. (CONF-670628-3). Dep. CFSTI.

From 10th International Conference on Cosmic Rays, Calgary, Alberta, Canada.

A large momentum spectrograph with 100 cm^2 sr aperture was used to measure the momentum spectrum and charge excess of cosmic-ray muons at zenith angles close to 75°. Preliminary results based on a small sample of events agree well with available data. (auth)

37185 (BNL-11546) SEARCH FOR HEAVY SINGLY CHARGED PARTICLES IN COSMIC RAYS. Kasha, Henry (Brookhaven National Lab., Upton, N. Y.); Hawkins, C. B. J.; Stefanski, R. J. (Yale Univ., New Haven, Conn.). [1966]. 8p. (CONF-670628-4). Dep. CFSTI.

From 10th International Conference on Cosmic Rays, Calgary, Alberta, Canada.

A search is being conducted for heavy singly charged particles which might be found in cosmic rays deep in the atmosphere. The search is particularly motivated by the possible existence of particles which might form fundamental triplet representations of SU_3. It has been possible to show that such particles will likely have velocities smaller than c near sea level if their angle of incidence is near 15° from the horizontal. The particles are identified by their momentum, charge, and time of flight through the apparatus. No such particles have been found and the preliminary data give a limit of 2.8×10^{-8} cm^{-2} sr^{-1} sec^{-1} at 90% significance level for particles with masses greater than 5 GeV/c^2 with a velocity between 0.5c and 0.75c. On the basis of a particular model of production and diffusion through the atmosphere this flux corresponds to a production cross section by nucleon-nucleon interactions of about 10^{-29} cm^2. (auth)

37186 (CONF-670628-5) THE ENERGY DEPENDENCE OF THE FRAGMENTATION PARAMETERS AND MEAN FREE PATHS OF COSMIC RAY NUCLEI WITH Z ≥ 10. Cleghorn, T. F.; Freier, P. S.; Waddington, C. J. (Minnesota Univ., Minneapolis. Cosmic Ray Group. [1967]. Contract Nonr-710(60). 8p. (CR-98).

From 10th International Conference on Cosmic Rays, Calgary, Alberta, Canada.

The fragmentation parameters and interaction mean free paths for VH- and H-type cosmic-ray nuclei were measured as functions of energy in nuclear emulsions. It was found that they are essentially independent of energy over the range from 100 MeV/n to 30 GeV/n. The mean free paths of the secondary nuclei produced in observed interactions were also measured. With two major exceptions, the values of the mean free paths are found to be consistent with an overlap model for nuclear interactions. The value obtained for the secondary L-type nuclei appears to be significantly shorter than that expected from the model calculations while that for the primary VH nuclei appears to be significantly longer. (auth)

37187 (CONF-670628-6) THE ENERGY SPECTRUM OF THE Z ≥ 20 COMPONENT OF THE COSMIC RADIATION. Freier, P. S.; Waddington, C. J. (Minnesota Univ., Minneapolis. Cosmic Ray Group). June 1967. Contract Nonr-710(60). 14p. (CR-99).

From 10th International Conference on Cosmic Rays, Calgary, Alberta, Canada.

Three large stacks of nuclear emulsions were exposed during 1964-1966 on high altitude balloons launched from Fort Churchill, Canada; Texas, U.S.A.; and Hyderabad, India. These stacks were used to study the energy spectrum of cosmic-ray nuclei of calcium and heavier, the so-called VH nuclei. These measurements result in integral intensity values for energies greater than 7.1, 1.58, and 1.00 GeV per nucleon, together with differential intensities over the range 225 ≤ E ≤ 1000 MeV per nucleon. Differential intensities were also found for lighter nuclei over varying energy ranges. The differential spectrum observed has a maximum value of about 1.6×10^{-3} nuclei/m^2 ster. sec. MeV per nucleon around E ≃ 350 MeV per nucleon and falls off at both higher and lower energies. These values are based on the observation of a total of some 1600 VH nuclei. The energy spectrum was compared with that observed at similar times for the helium nuclei in order to study the influences of ionization energy losses during propagation of these high-Z nuclei. These observations are interpreted as implying that if the source spectra of the VH nuclei and the helium nuclei are similar then the VH nuclei have traversed less than 1 g/cm^2 of matter while ionization energy loss has been the dominant acceleration term. (auth)

37188 (CONF-670628-7) CHARGE DISTRIBUTION OF THE ENERGETIC VERY HEAVY NUCLEI IN THE PRIMARY COSMIC RADIATION. Mathiesen, O.; Long, C. E.; Freier, P. S.; Waddington, C. J. (Minnesota Univ., Minneapolis. Cosmic Ray Group). [1967]. Contract Nonr-710(60). 13p. (CR-100).

From 10th International Conference on Cosmic Rays, Calgary, Alberta, Canada.

A fully digitized, semi-automated photodensitometer was employed to study the detailed charge composition of primary cosmic-ray nuclei having Z ≥ 16 detected in a stack of nuclear emulsions flown from Hyderabad, India, under approximately 4 g/cm^2 of residual atmosphere. One hundred and twenty nuclei heavier than phosphorus were analyzed. These nuclei all had energies exceeding 7.1 GeV per nucleon and have had their charges measured with an accuracy estimated to be ±0.4 of a unit charge. It has consequently been possible to resolve the individual charges and to determine the elemental abundances. The observed charge distribution has been corrected to the top of the atmosphere and compared with various cosmological abundance compilations. After deriving values for the fragmentation parameters in hydrogen, it is concluded that the data are consistent with the charge distribution predicted if an initially pure example of iron nuclei had traversed some 4 g/cm^2 of matter since the initial acceleration. The cosmologically abundant elements sulfur, argon, and calcium appear to be relatively absent from the source, while nickel is only present with the predicted abundance. (auth)

37189 (ESRO-SP-6, Paper 4) RAYONS COSMIQUES ET RAYONNEMENT SYNCHROTRON. (Cosmic Radiation and Synchrotron Radiation). Lequeux, J. (Observatoire de Paris-Meudon (France)). 52p. (In French).

Synchrotron radiation is a particularly interesting source of information for relativistic electrons and regions where the concentrations of cosmic rays and magnetic fields are strong, and which are probably sources of cosmic rays. After a brief review of the properties of synchrotron radiation, discrete radiosources, which emit totally by synchrotron radiation and are therefore very probably sources of cosmic rays are reviewed. Acceleration, injection, and propagation of cosmic rays are studied. Two processes of acceleration are of great importance: the betatron process and the Fermi process. With regard to losses and leakage, these largely determine the energy spectra. Propagation is then studied by means of two possible models: that of lines of force and that of inhomogeneities. Energy losses in the course of propagation are studied. Fragmentation by collisions and the creation of secondary electrons are examined. The experimental results bring to light the superabundance of light elements and information on the composition of electronic radiation. It is considered that in order to know the origin of cosmic electrons one must perfect the galactic model, measure the agreement e^+/e^-, and measure the electron spectra in the region of 0.25 GeV for the purpose of comparison with the synchrotron radiation spectra. (tr-auth)

37190 (ESRO-SP-6, Paper 5) COSMIC RADIATION. Marsden, P. (Leeds Univ. (England)). 24p.

The purpose of the lecture is to present, essentially from an experimenter's point of view, the major features of the cosmic radiation. The general characteristics of cosmic rays are reviewed: their composition (nuclear and electron components, gamma rays, and neutrinos), their energy spectra and their anisotropy (a slight anisotropy seems to exist in the center of the galaxy). The motion of a cosmic-ray particle is discussed. Some methods of monitoring cosmic-ray intensity are briefly described: the most useful type of ground-based recorder is the neutron monitor, followed by the μ-meson telescope. Some intensity variations are described (11-year and diurnal variations, Forbush effect, cosmic-ray flares), and the theory of cosmic-ray modulation is discussed, invoking Parker's solar wind model. (auth)

37191 (ESRO-SP-6, Paper 14) SOME UNRESOLVED PROBLEMS IN THE CORPUSCULAR COSMIC RADIATION. Peters, B. (Copenhagen Univ. (Denmark)). 17p.

Some of the most important problems in present and future cosmic-ray research are considered. The role played by cosmic rays in the evolution of the solar system is discussed, as well as methods of obtaining information on the history of both galactic and solar cosmic rays. It is shown how the production and acceleration of galactic cosmic rays as well as fragmentation in interstellar space may be investigated by carrying out specific measurements. A list of such experiments is given and the technical difficulties involved are discussed. The measurement of solar neutrons and its implications for the study of solar transient phenomena are considered. (auth)

37192 (ESRO-SP-6, Paper 16) EXPERIMENTAL OBSERVATIONS OF PRIMARY COSMIC-RAY ELECTRONS. Scarsi, L. (Milan Univ. (Italy). Istituto di Scienze Fisiche). 26p.

Some of the astrophysical implications of studies on galactic cosmic-ray electrons are mentioned. The various difficulties encountered in the measurement of these electrons are discussed. The experimental results which were obtained so far by balloon-borne and also by satellite-borne instruments are critically reviewed. A summary of the results is presented. (auth)

37193 (N-67-18124) [HIGH RESOLUTION COSMIC RAY CHARGED PARTICLE TELESCOPE]. Status Report, October 16, 1966-January 20, 1967. Kaplon, M. F. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). Jan. 24, 1967. 24p. (NASA-CR-81781). CFSTI.

Detector and associated electronics are described for a high resolution cosmic-ray charged-particle telescope; and detector

results are presented for three flights during the summer of 1966. Because of a poor time–altitude flight curve and equipment malfunction, the first flight yielded no useful information; the other two flights in which the detector floated at 2.7 gm/cm^2 produced identical results. Typical responses are shown for the detectors to sea-level μ mesons under various conditions. Clear separation of protons and deuterons is seen in plots for the region of pulse heights containing mainly Z = 1 particles; and another scale emphasizes the Z = 2 particles. The deuteron differential energy spectrum required a large correction for deuterons produced in the residual atmosphere, but contained a finite flux of primary deuterium that indicates an interstellar path length consistent with that applied to the ^{3}He–^{4}H data. Deuteron resolution for the 100- to 125-MeV interval is tabulated. (STAR)

37194 (N-67-19863) CROSS-SECTION INFORMATION REQUIRED FOR THE CALCULATION OF THE PROPAGATION OF COSMIC RADIATION THROUGH INTERSTELLAR SPACE. Reames, D. V. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Feb. 1967. 16p. (NASA-TM-X-55715; X-611-67-88). CFSTI.

The need for reliable cross section data is stressed to increase knowledge of interstellar space, the nature of the cosmic-ray source, and of the mechanism by which the particles are accelerated. Reactions of interest involve protons of energy ≥10 MeV incident on target nuclei which are the most abundant constituents of the cosmic-ray flux. Target nuclei for which detailed energy-dependent fragmentation information is required include the stable isotopes of He, B, C, N, O, Ne, Mg, Si, Ca, and Fe. Reactions of greatest interest for cosmic-ray calculations are usually those that have the largest cross sections. Specific reactions include: the p + ^{4}He reaction, light nucleus production and loss, fragmentation of medium nuclei, F, Na, and Al and the fragmentation of nuclei with 9 ≤ Z ≤ 14, and fragmentation of the iron-group nuclei. The need for data on total reaction cross sections and for ^{4}He-induced reactions is also emphasized. (STAR)

37195 (N-67-20341) LINEAR ENERGY TRANSFER SPECTRA AND DOSE EQUIVALENTS OF GALACTIC RADIATION EXPOSURE IN SPACE. Schaefer, Hermann J. (Naval School of Aviation Medicine, Pensacola, Fla.). Dec. 9, 1966. 17p. (NASA-CR-82999; NAMI-987). CFSTI.

In assessing the astronaut's exposure from galactic cosmic rays on space missions of long duration, conversion of absorbed doses to dose equivalents is required. Since a large part of the dose contribution from heavy primaries is produced at LET values beyond the range for which radiobiological data are available, it seems preferable to analyze the LET distributions themselves and to compare them to standard x rays rather than to assume arbitrary values for the RBE. The local LET distributions in tissue are found to be extremely skewed, with a large maximum at the relativistic minimum LET. Lined up on the LET scale, they cover the very wide interval from 0.18 to 2790 keV/micron T as compared to an interval from 0.4 to 35 keV/micron T for standard x rays. Applying the RBE formula and a saturation value of 10 leads to a grand mean RBE of 1.82 for the total absorbed dose of 13 mrad/24 hours from primaries. (auth) (STAR)

37196 (NYO-3038-7) ENERGETIC PARTICLES AND THE BACKGROUND RADIATION. Greisen, Kenneth (Cornell Univ., Ithaca, N. Y.). July 1967. Contract AT(30-1)-3038. 52p. (CONF-670119-1). Dep. CFSTI.

From 1967 Texas Symposium on Relativistic Astrophysics, New York.

The effects of the interaction of background radiation with energetic particles fall into two classes, both of which are of potential interest in proofing the external universe: absorptive effects and productive effects. After a brief survey of the nature of the radiation field itself, the following are discussed: absorption effects; (1) energy drain on fast electrons, (2) absorption of high-energy photons, (3) breakup of cosmic nuclei, and (4) energy drain on fast protons: Produced radiation; (1) diffuse x and γ radiation from all space, (2) x and γ radiation by Doppler-shifted reflection from discrete sources, (3) vacuum cascade leading to a prominence in the photon spectrum between 10^{13} and 10^{14} eV, (4) primary photons around 10^{19} eV, (5) primary high-energy neutrons, and (6) very high-energy neutrinos. (W.D.M.)

37197 (N-67-18741) INVESTIGATION OF X-RAY EMISSION OF THE MOON WITH THE HELP OF AMS "LUNA-10". Mandel'shtam, S. L.; Tindo, I. P.; Karev, V. I. Translated from Kosm. Issled., Akad. Nauk SSSR, 4: 827-37(1966). 14p. (NASA-CR-82097). CFSTI.

A calculation is presented of fluorescent characteristics of silicon, aluminum, and magnesium lines in the composition of the surface layer of lunar rocks excited by x radiation of the sun. Description is given of the apparatus designed for the experimental detection of moon's x-ray emission and installed aboard AMS Luna-10. The results of the measurements are brought forth, in the course of which was determined the cosmic background level in the vicinity of the moon, detecting at the same time the electrons with energy greater than 40 keV of the earth's magnetosphere tail. The preliminary data on the registration of x radiation are also given. (auth)

37198 (N-67-18772) RELATIONSHIP OF X-RAY EMISSION OF SOLAR FLARES WITH THEIR EFFECTS IN COSMIC RAYS. Vladimirskii, E. M.; Pankratov, A. K. Translated from Izv. Krym. Astrofiz. Observ., 32: 46-55(1964). 18p. (NASA-TT-F-9643). CFSTI.

From the comparison of ionospheric effects of flares with small increase in cosmic-ray intensity (less than one percent) at sea level (nucleon component), the following conclusions are drawn. More powerful effects in the D of the ionosphere correspond, as an average, with more substantial increases of cosmic-ray intensity at sea level. The appearance of absorption in the D constitutes a necessary but not sufficient indication of the occurrence of a small effect in cosmic rays at sea level. (auth)

37199 ENERGY SPECTRUM AND THE ORIGIN OF COSMIC-RAY ELECTRONS ABOVE 12 GeV. Shen, C. S. (Purdue Univ., Lafayette, Ind.). Phys. Rev. Lett., 19: 399-402(Aug. 14, 1967).

Various suggestions that have been put forward to explain the energy spectrum and the positron excess observed in recent measurements on high-energy cosmic-ray electrons are considered. It is pointed out that in the high-energy range where the radiative lifetime of an electron is shorter than its leakage lifetime, the equilibrium energy spectrum of electrons at Earth depends strongly on the spatial distribution of their sources. Thus, assuming the existence of the 3°K blackbody radiation and a leakage lifetime of 10^8 y for both cosmic-ray nuclei and electrons, the electron spectrum above 10 BeV will provide a tool to determine the origin of cosmic-ray electrons. (L.B.S.)

37200 NEUTRON MULTIPLICITY MONITOR OBSERVATIONS DURING 1965. Nobles, R. A.; Alber, R. A.; Hughes, E. B.; Newkirk, L. L.; Walt, M. (Lockheed Palo Alto Research Lab., Calif.). J. Geophys. Res., 72: 3817-27(Aug. 1, 1967).

The multiplicity, i.e., the average number of neutrons m produced per incident particle in a neutron monitor, increases with the energy of the producing radiation. A monitor designed to take maximum advantage of the information contained in this effect has been used to study the characteristics of the cosmic radiation at White Mountain (3800-meters elevation) and at Palo Alto (sea level) during 1965. The energy dependence of the incident differential nucleonic flux was found to be $N(E) \sim E^{-\gamma}$, with $\gamma = 1.96$ at 3800 meters and 2.20 at sea level. Barometric pressure coefficients for the total neutron counting rate were found to be −1.022 and −0.958% per mmHg at the mountain and sea-level locations, respectively. These values are in good agreement with results previously reported for other neutron monitors. The pressure coefficients for the multiplicity m = 1 counting rates were found to be −0.97% per mmHg at 3800 meters and −0.89% per mmHg at sea level. At both elevations the coefficients increased with multiplicity to the same median value of about −1.13% per mmHg at m ≥ 7. The relatively lower values found for the pressure coefficients for the sea-level total count and low multiplicity rates are attributed to a contribution by μ-meson capture neutrons. Aside from the meson effect, the variation of the pressure coefficients with multiplicity is in qualitative agreement with the observed altitude variation of the spectral index γ. (auth)

37201 THE INTENSITY OF HEAVY NUCLEI IN THE PRIMARY COSMIC RAYS OVER TEXAS IN MARCH 1962 AND THE SOLAR CYCLE MODULATION. Biswas, S. (Goddard Space Flight Center, Greenbelt, Md. Tata Inst. of Fundamental Research, Bombay). J. Geophys. Res., 72: 3801-8(Aug. 1, 1967).

The intensities of heavy nuclei with Z ≥ 6 in the primary cosmic radiation were measured with a nuclear emulsion stack exposed in a balloon flight over Texas on March 26–27, 1962, and the intensities of M(6 ≤ Z ≤ 9) and H(Z ≥ 10) nuclei extrapolated to the top of the atmosphere were found to be 6.20 ± 0.46 and 2.02 ± 0.25 particles/m^2 ster sec, respectively. Results of this work and those of other investigations made during the last solar cycle (1954–1964) are used to study the long-term solar modulation of primary S nuclei (Z ≥ 6) of rigidity ≥4.8 BV. It is found that the lag between the primary intensity changes and the sunspot number is about one and one-half years during the increasing phase of solar activity and is very small during the declining phase of solar activity. (auth)

37202 MEASUREMENT OF COSMIC-RAY NEUTRON DOSE. Huq, M. S. (Dacca Univ., Pakistan). J. Natur. Sci. Math., 6: 183-97(Oct. 1966).

Cosmic radiation generates neutrons which irradiate human tissues. Experiments were performed to assess typical dose rates to soft tissues from this component of the background ra-

diation. Two large high-pressure ionization chambers were used, one of which was filled with hydrogen and the other with argon. Ionization currents in the two chambers were compared under conditions which allow the several components of background radiation to be distinguished. The responses of the two chambers to artificial sources of neutrons and of gamma rays were also compared. When corrections for ionization recombination and other effects are applied, it is possible to calculate the contribution of cosmic-ray neutrons to the ionization current in the two chambers. It is concluded that the first-collision dose rate to soft tissues from cosmic-ray generated neutrons is typically (1.54 ± 0.25) mrad/yr. (auth)

37203 NATURAL X RADIATION, ITS DISCOVERY, ITS ORIGIN, AND ITS RECENT INVESTIGATION. Borcke, E. (Agfa-Gavaert AG, Munich). Roentgenpraxis, 20: 8-20(Jan. 1967). (In German).

The author establishes diagrammatically relations between various types of radiations and their occurrence. The altitudes characteristic of natural radiation with wavelengths up to 3000 Å are shown for altitudes up to ~160 km. The relative intensities of solar shortwave radiation, as measured in the upper atmosphere, are plotted as functions of wavelengths from 3 to more than 1000 Å for small eruptions, active corona, and the normal x-ray spectrum of the Sun. The alterations of the shortwave fractions vary as a function of solar activity. The occurrence of coronal green, red, and yellow lines, plage regions, dark filaments, and prominences on solar flares are charted and described for the period of the Oct. 12, 1958 eclipse. X-ray photographic exposures of the Sun taken at 20 to 60 Å on 10/19/60 are shown and discussed. Results of isodose measurements made in the area of Scorpio are diagrammed and discussed. A view of the Crab nebula, taken with x rays up to 280 sec greater than the background radiation, with the max alteration of 230 sec is presented and discussed. (BBB)

37204 THE COSMIC-RAY ELECTRON SPECTRUM IN A DISC–HALO GALACTIC MODEL. O'Connell, R. F.; Sofia, S. (Goddard Space Flight Center, New York). Nuovo Cim. (10), 50B: 359-61(Aug. 11, 1967).

It is demonstrated that there are certain inconsistencies in the analysis of Ramaty and Lingenfelter (Phys. Rev. Lett., 17: 1230 (1966), and it is shown that the disc–halo model is consistent only with a model for which the ratio of the absolute normalizations is very close to 1, with a resultant spectral index of about 2.5. In other words, the disc–halo model becomes practically indistinguishable from the no-halo model of O'Connell (Phys. Rev. Lett., 17: 1232(1966)). (W.D.M.)

37205 HIGH ENERGY PHOTONS FROM THE CRAB NEBULA DUE TO THE UNIVERSAL MICROWAVE FIELD. Apparao, M. V. K. (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A, 65: 349-52(June 1967).

The flux of high-energy photons emanating from the Crab Nebula due to inverse Compton scattering of the universal microwave from the high-energy electrons in the Nebula was calculated. This flux is compared with experimentally obtained values at certain energies and also with the flux calculated due to the Compton–synchrotron process. The flux of γ rays of about 100 MeV due to the scattering of the microwave photons is found to be of the same order as that due to the Compton–synchrotron process. (auth)

37206 RECENT OBSERVATIONS ON COSMIC ELECTRONS AND THEIR CONSEQUENCES ON DIFFERENT COSMIC RAY MODELS AND RELATED ASTROPHYSICAL QUANTITIES. Daniel, R. R.; Stephens, S. A. (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A, 65: 319-39 (June 1967).

An experiment was carried out to study the electron component of the primary cosmic radiation at energies >12 GeV using a hypersensitized nuclear emulsion stack, flown oriented in the east–west plane over Hyderabad, India. The results of this experiment, on the basis of 28 identified electrons of energy above 12 GeV, are: (i) the integral flux of electrons above an effective energy of 16 GeV is 0.51 ± .10 per m^2 sec sr; (ii) the differential energy spectrum between 12 and 300 GeV can be represented as $N(E)dE = 12.7\ E^{-2.1\pm.2}\ dE\ m^{-2}\ sec^{-1}\ sr^{-1}$; and (iii) the fraction of positrons among the total electrons in the energy region 12 to 30 GeV is discussed. A critical study was made on the applicability of different cosmic-ray models by making use of the observed differential energy spectrum of electrons and the relevant astrophysical parameters associated with the confinement region. The confinement regions considered are: (i) the universe as a whole, (ii) the super cluster to which our galaxy belongs, (iii) the galactic halo, and (iv) the galactic disc. The consequences of the recently postulated universal black body radiation at 3°K. on the cosmic-ray models are also considered. Some of the crucial experiments needed to set more stringent constraints on the models which would then permit meaningful interpretation, are enumerated. (auth)

37207 ARRIVAL TIME DISTRIBUTION COMPUTATION FOR PARTICLES OF THE E. M. COMPONENT IN EAS. Locci, M. A.; Picchi, P.; Verri, G. (CNEN, Frascati, Italy). Nuovo Cim. (10), 50B: 384-8(Aug. 11, 1967).

Particles of the electromagnetic component in an EAS may be delayed with respect to one another at the plane of observation because of different energy and nature and statistical manner of interaction. The behavior of the instantaneous spatial density distribution is calculated with the Monte Carlo method. It is concluded that at a given instant most electrons with energies $E \geq 10$ MeV lie in a disk of thickness between 1 and 2 m. (W.D.M.)

37208 SIMULATING THE OPERATION OF AN IONIZATION CALORIMETER. Rylov, Yu. A. Kosm. Issled., 5: 130-9(Jan.-Feb. 1967). (In Russian).

The parameters describing the elementary processes taking place in an ionizing calorimeter upon the entry of a high-energy ($>10^{12}$ ev) cosmic particle were investigated. The study is based on a simplified model for the elementary process, and the calculations are carried out by the Monte Carlo method. The most probable and average energy of the impinging particle were calculated. In addition, the most probable error and average error in the energy and the dependence of the quantities on the number and distribution of detectors in the ionizing calorimeter were determined. Expressions for the energy dispersion D(E) and most probable error in E, ΔE, are presented, and the error is determined. A comparison of results obtained with the aid of a most probable method of Yu. A. Rylov and G. A. Skuridin (Yadern. Fiz., 2: 691, (1965)) and with the calorimetric method was carried out. The experimental results are summarized. It was found that the most probable method for energy evaluation yields poorer results than the calorimetric method, especially for larger calorimetric thicknesses. It is concluded that, if the present estimations are correct, the fraction of the total energy lost by the primary particle in the calorimeter "Proton-1" is of the order of 60%, with an average experimental error of 25%. (ATD)

37209 EXTENSIVE AIR SHOWERS OBSERVED IN THE EMULSION CHAMBER. Akashi, M. (Hirosaki Univ., Japan); Watanabe, Z.; Nishimura, J.; (and others). Notas Fis., Cent. Brasil. Pesqui. Fis., 12: No. 16, 283-304(1967).

Large emulsion chambers (about 10 m^2 area) exposed at mountain altitudes (5500 m and 2800 m) provide a means of observing the highest-energy particles of EAS cores. Lateral distribution of the high energy γ rays in a cascade shower, properties of successive interactions in the atmosphere, and analysis of the core structure are discussed, using the data observed in the chamber. (auth)

37210 HIGH-TRANSMISSION SPECTROMETER FOR NUCLEAR CHARGES OF PRIMARY COSMIC RAYS. Volodichev, N. N.; Grigorov, N. L.; Kislyakov, O. V.; Mineev, Yu. V.; Nesterov, V. E.; Nechaev, O. Yu.; Rapoport, I. D.; Savenko, I. A.; Stirnov, A. V.; Yakovlev, B. M. Kosm. Issled., 5: 119-23(Jan.-Feb. 1967). (In Russian).

A Cherenkov spectrometer for charged nuclei with the geometric factor $G = 133 \pm 6$ $cm^2 \cdot$ sterad, installed in the Proton-1 and Proton-2 for measurement of the flux and chemical composition of the cosmic radiation in the charge range from 1 to 50, is described. (tr-auth)

37211 PRELIMINARY DATA ON γ RADIATION FROM MOON SURFACE MEASURED BY LUNA 10 COSMIC STATION. Vinogradov, A. P.; Surkov, Yu. A.; Chernov, G. M.; Kirnozov, F. F.; Nazarkina, G. B. Kosm. Issled, Akad. Nauk SSSR, 4: 871-9(Nov.-Dec. 1966). (In Russian).

The intensity and spectral composition of γ emission from the moon were measured by means of a γ spectrometer installed in Luna 10. The γ intensity recorded was 20 to 30 μR/hr. Cosmic-ray interactions with lunar substances are the main contributors to the γ radiation. (R.V.J.)

37212 CORPUSCULAR RADIATION DETECTION ON THE COSMIC SATELLITE LUNA 10. Grigorov, N. L.; Maduev, V. L.; Pisarenko, N. F.; Savenko, I. A. Kosm. Issled. Akad. Nauk SSSR, 4: 842-50(Nov.-Dec. 1966). (In Russian).

Data are presented on the cosmic radiation measured in the Luna 10 satellite; the measuring apparatus is described. The intensity of the primary cosmic radiation in the interplanetary space was determined. The albedo for the primary radiation in relation to the lunar surface was measured in the satellite orbit. Data are also given on the soft corpuscular radiation flux in the "tail" region of the earth's magnetosphere. (tr-auth)

37213 STUDIES OF THE NUCLEAR COMPONENT OF THE PRIMARY COSMIC RAYS ON THE PROTON-2 SATELLITE.

Volodichev, N. N.; Grigorov, N. L.; Nesterov, V. E.; Nechaev, O. Yu.; Podorol'skii, A. N.; Rapoport, I. D.; Savenko, I. A. Kosm. Issled., 5: 115-18(Jan.-Feb. 1967). (In Russian).

The results of the measurement of the nuclear component of primary cosmic radiation carried out on the ISZ Proton-2 by means of the Cherenkov spectrometer CEZ-1 on the 105 to 113 orbit of the Sputnik trajectory are described. (tr-auth)

37214 MEASURING DEVICE FOR HIGH-ENERGY GAMMA QUANTA IN THE PRIMARY COSMIC RADIATION. Grigorov, N. L.; Kalinkin, L. F.; Melioranskii, A. S.; Nesterov, V. E.; Pryakhin, E. A.; Savenko, I. A.; Sysoev, E. A.; Estulin, I. V. Kosm. Issled., 5: 124-9(Jan.-Feb. 1967). (In Russian).

The instrument is a telescope with directional actions, designed for the measurement of the intensity and spectral composition of γ radiation with energy $E_\gamma \gg 50$ MeV in the presence of a charged particle background. The separation of the registration of γ quanta and neutrons and the elimination of the imitation of γ radiation by charged particles was provided for. The apparatus was tested in measurements of cosmic radiation at sea level and on γ quanta bursts from a synchrotron. The operation of the device on the Proton-1 and Proton-2 was illustrated. (tr-auth)

37215 ON THE CHERENKOV LIGHT IN 10^{12}- TO 10^{14}-eV EXTENSIVE AIR SHOWERS. Castagnoli, C. (Univ., Turin); Locci, M. A.; Picchi, P.; Verri, G. Nucl. Phys., B2: 369-82 (1967).

The lateral and time distribution of the Cherenkov light from an electromagnetic cascade shower in the atmosphere was calculated with a Monte Carlo method. The primary energies were assumed to be 10^{12}, 10^{13}, and 10^{14} eV. The results of the calculation are in agreement with experimental measurements. (auth)

37216 ATMOSPHERIC ELECTRIC FIELD AS A POSSIBLE CAUSE OF RADIO PULSES FROM EXTENSIVE AIR SHOWERS. Charman, W. N. (Atomic Energy Research Establishment, Harwell, Eng.). Nature (London), 215: 497-8(July 29, 1967).

Various mechanisms have been proposed for the origin of the radio pulses found to be associated with large cosmic-ray extensive air showers. All of these mechanisms depend essentially either on enhanced Cherenkov radiation from electron excess in the shower, or on charge separation effects in the Earth's magnetic field. It appears that charge separation by the electric field of the lower atmosphere may play a significant part under certain atmospheric conditions. This is discussed, and it is concluded that only transverse separation is capable of producing radio emission yields comparable with those which can be produced by geomagnetic charge separation and charge excess. Both the direction and amount of the electrically produced charge separation will depend on the local atmospheric electric field along the shower track, and thus the magnitude and polarisation of the radio emission produced will vary widely with local climatic factors. This may reduce the usefulness of the observed intensity of radio emission as a measure of the size of extensive air showers. (UK)

37217 RELATION OF WEAK COSMIC-RAY BURSTS TO A_p CHARACTERISTICS OF THE GEOMAGNETIC ACTIVITY AND THE PROPAGATION IN INTERPLANETARY SPACE OF ENERGETIC SOLAR COSMIC RAYS. Dorman, L. I.; Sergeev, A. V. (Izmiran, Moscow). J. Atmos. Terrest. Phys., 29: 449-52(Apr. 1967).

The relation between weak bursts of cosmic rays and the A_p characteristic of geomagnetic activity is considered, and its bearing on the nature of propagation of the high-energy part of solar cosmic rays in interplanetary space is discussed. (auth) (UK)

37218 SOUNDING OF INTERPLANETARY SPACE BY SOLAR COSMIC RAYS. Dorman, L. I.; Miroshnichenko, L. I. (Izmiran, Moscow). J. Atmos. Terrest. Phys., 29: 385-94(Apr. 1967).

The dependence of the solar cosmic-ray diffusion coefficient upon the cosmic-ray energy and distance to the Sun was studied and the magnetic field strength in the inhomogeneities, their dimensions and distances between them were evaluated. The spectrum of the solar particle generation in the energy range 1 to 1000 MeV was obtained for the flare on September 28, 1961. The influence of the duration of the solar cosmic-ray ejection from the acceleration region on the cosmic-ray spatial distribution in interplanetary space is discussed. The multiplicities of the generation of the neutron and hard component in the Earth's atmosphere were calculated. The rigidity spectrum for the 1- to 15-BV range was obtained at the atmospheric boundary for the particles from the flare on February 23, 1956. An attempt is made to explain some features of the energy spectrum of the solar cosmic rays, taking account of the combined dependence of the diffusion coefficient upon the particle energies and distance to the Sun. The geo-effectiveness of the solar cosmic-ray bursts on September 28, 1961, and July 14–15, 1959, was evaluated. (auth) (UK)

37219 SPECTROMETRY OF PRIMARY AND SOLAR PROTONS AT SKOGAR, ICELAND ($L \simeq 5.7$). Cambou, F.; Guyader, J. C.; Reme, H. (Centre d'Etude Spatiale des Rayonnements, Toulouse). J. Atmos. Terrest. Phys., 29: 419-27(Apr. 1967). (In French).

The proton spectrometer used comprises a telescope consisting of two scintillation-type counters and a Cherenkov counter, which allows protons of a higher energy than 1 GeV to be eliminated. The spectrum, which is measured from the loss of specific energy of the particles in a thin cesium iodide scintillator, is coded and transmitted to a 100-channel amplitude analyzer. The results presented relate to two releases of balloons from the South of Iceland (Summer, 1965). The spectra obtained bring out the contribution of protons of solar origin (19th August) and that of primary galactic protons (4th September). (auth) (UK)

37220 PROPAGATION OF ENERGETIC PARTICLES THROUGH INTERPLANETARY SPACE ACCORDING TO THE DATA OF 11-YR COSMIC-RAY VARIATIONS. Dorman, I. V.; Dorman, L. I. (Izmiran, Moscow). J. Atmos. Terrest. Phys., 29: 429-47(Apr. 1967).

The size of the region occupied by the solar wind and the transport scattering path of the particles of various energies are determined and the change in the spectrum of magnetic inhomogeneities in the wind with changing solar activity is studied on the basis of investigation of the 11-yr variations of cosmic rays of relatively high energies taking account of the lag of the change in the conditions in the interplanetary space with respect to the processes on the Sun. The solar wind properties are also found for the period of solar minimum. The residual modulation for the particles of various energies at solar minimum is determined and the true cosmic-ray intensity beyond the region of the solar wind is evaluated. Analysis of the expected variations in the ranges of various energies for the protons, α particles, and electrons of the galactic cosmic rays is also carried out. The spectrum of the cosmic-ray rigidities beyond the modulation region outside the solar system is determined. It has been shown that an essential part of the "bend" of the spectrum is due to modulation in interplanetary space. Other possible causes of the "bend" are also discussed. The expected gradient of the cosmic-ray intensity in interplanetary space is evaluated as a function of Z and particle rigidity. The results obtained on the gradient are in agreement with the data from "Mariner 2". The change in the electromagnetic conditions in the planetary space with decrease in solar activity is evaluated according to the data of the stratospheric measurements in July, 1963, and of "IMP-1" measurements. (auth) (UK)

37221 VARIATION IN THE BACKGROUND COUNTING RATE AT TIRUPATI DURING THE PERIODS OF SOLAR AND LUNAR ECLIPSES. Rao, J. N. Ananda (Sri Venkateswara Univ., Tirupati, India). Phys. Lett., 25A: 74(July 31, 1967).

Background counting at Tirupati (South India) was studied during the periods of lunar eclipses on Dec. 30, 1963, June 25, 1964, and Dec. 19, 1964. The results indicated interesting deviation from the normal background counting rate. The experiment was repeated during the periods of solar eclipses. The background counting rate was found to increase during periods of lunar eclipse and to decrease during periods of solar eclipse. (W.D.M.)

37222 SECONDARY ANTIPROTONS IN GALACTIC COSMIC RADIATION. Rosen, Stephen (Adelphi Univ., Garden City, N. Y. State Univ. of New York, Bronx). Phys. Rev., 158: 1227-36(June 25, 1967).

Calculations are presented of the production of secondary antiprotons due to inelastic collisions of high-energy primary cosmic rays with interstellar gas nuclei. Cosmic-ray diffusion theory is assumed to apply in the steady-state approximation, with a constant average beam intensity taken over space. The cosmic-ray energy spectrum, production thresholds, cosmic-ray and target abundances and densities, and production and annihilation cross sections are examined and utilized. The results give a very approximate energy spectrum for the antiproton flux. Astrophysical ramifications of this collision source of antiprotons are discussed in light of the dominance of leakage over annihilation as a mechanism of antiproton loss. (auth)

37223 STEADY STATE OF COSMIC-RAY NUCLEI: THEIR SPECTRAL SHAPE AND PATH LENGTH AT LOW ENERGIES. Cowsik, R.; Pal, Yash; Tandon, S. N.; Verma, R. P. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 158: 1238-42 (June 25, 1967).

The steady state of cosmic-ray nuclei in interstellar space is discussed. It is shown that for a steady-state situation (or for any mode of propagation in which the allowed path lengths between the source and observer have a wide distribution), the generally used matter-slab approximation for the interstellar matter traversed by cosmic rays leads to erroneous conclusions. The steady-state energy spectra of heavy nuclei are found to have negative slopes down to energies ~50 MeV/N, if the injection spectra are like a rigidity power law; this offers an explanation for the apparently

surprising observation of flat spectra for heavy nuclei down to energies ~50 MeV/N. Further it is found that the L/M ratio cannot keep on increasing at low energies but must decrease continuously below a few hundred MeV/N, even for energy-independent fragmentation cross sections; this also is in accord with recent experimental results. (auth)

Direct Energy Conversion

Refer also to abstract 36781.

37224 CHARACTER OF INTERACTION OF ZIRCONIUM CARBIDE WITH CESIUM VAPOR. Samsonov, G. V.; Podchernyaeva, I. A.; Fomenko, V. S. (Inst. of Material Science Problems, Kiev). Teplofiz. Vys. Temp., 5: 161-3(Jan.-Feb. 1967). (In Russian).

Results are reported of a preliminary investigation of thermionic emission characteristics of zirconium carbide in vacuum, using apparatus and a procedure described earlier. The reason for the investigation was the possible application of such an emitter for thermal electronic energy conversion. In the present investigation, measurements were made in sealed diodes in Cs vapor. The cathode was a narrow tantalum ribbon, coated with a thin layer of ZrC, and the anode and guard electrodes were made of tantalum. The results show that the emission current density increases with increasing cathode temperatures, and is strongly affected by the cesium vapor pressure. The volt–ampere characteristic of such a diode shows an extended flat region. The results indicate that the interaction between the ZrC surface and the cesium vapor has a purely adsorption character, with the adsorbed layers produced by an electronic mechanism. Although the current density is too low to recommend the use of ZrC as cathode material, at the investigated range of temperatures (1600 to 2000K), the high binding energy of the adsorbed cesium films at medium temperatures suggest that this may be a stable metal-film cathode with good emission properties. (ATD)

37225 KNUDSEN LOW-VOLTAGE DISCHARGE WITH HOT CATHODE. Byrdin, Yu. A.; Lyubimov, B. Ya.; Nastoyashchii, A. F. Teplofiz. Vys. Temp., 5: 25-31(Jan.-Feb. 1967). (In Russian).

A Knudsen discharge is defined as a discharge between two plane-parallel electrodes under conditions when the particle free paths exceed the length of the gap. The investigation was aimed at determining whether free mixing of the particles would make the plasma in such a discharge more homogeneous and useful for neutralization of the space charge in thermionic converters. The electron energy distribution and simple formulas for the volt–ampere characteristics are determined on the basis of simple physical considerations regarding the particle and energy balance. The results of the theoretical analysis were checked experimentally in a Knudsen diode with plane-parallel geometry, using a niobium cathode and a nickel anode, at argon pressures 0.3 to 1.0 mm Hg. The experimental results agreed with the theoretical predictions. A curious peculiarity of the arc was the presence of a relatively dense cold plasma with an electron density much larger than the electron density in the beam, and with a Maxwellian velocity distribution. The results confirm the possibility of using such a discharge for neutralization of the space charge and also explain the origin of the Langmuir paradox. (ATD)

37226 DISCUSSION ON ADVANCED METHODS OF ENERGY CONVERSION: MAGNETOHYDRODYNAMIC POWER GENERATION. Rotherham, L. Phil. Trans. Roy. Soc. London, Ser. A, 261: 345-582(July 6, 1967).

Seventeen papers on the design, development, and performance of magnetohydrodynamic generators are included. Individual abstracts were prepared for each. (J.H.M.)

For abstracts of individual papers see: 37227–37243.

37227 THE SCIENCE OF MHD GENERATORS: A CRITICAL SURVEY. Wright, J. K. (Berkeley Nuclear Labs., Eng.). Phil. Trans. Roy. Soc. London, Ser. A, 261: 347-59(July 6, 1967).

Various types of MHD generators are briefly discussed and the basic theory of MHD generation is described. The open-cycle fossil-fuel type of MHD generator system in which the exhaust gases from the MHD duct are used to power a steam turbo-alternator generator is discussed in detail and the major problem areas identified. These include the stability of the flow in the MHD duct, the provision of long-lived electrodes, air preheaters, seed recovery apparatus and the development of a suitable superconducting magnet. The influence of the parameters of the various components on the performance of the complete MHD/steam turbine plant is discussed. (auth)

37228 RECENT PROGRESS IN THE DEVELOPMENT OF COMBUSTION FIRED MHD GENERATORS. Brogan, T. R. (Avco-Everett Research Lab., Everett, Mass.). Phil. Trans. Roy. Soc. London, Ser. A, 261: 360-7(July 6, 1967).

Recent progress is reported on the development of the large combustion-fired MHD generator with particular emphasis on commercial central station application. The segmented-electrode Faraday-configuration MHD generator is highly efficient but has the disadvantage of delivering its output in a multiplicity of loads each of which floats at a different potential. For this reason recent work in MHD generator fluid mechanics and long-duration channel development has been concentrated on examination of the high-voltage two-terminal Hall configuration, and this work is described. The chemistry and economics of seeding must be carefully evaluated in order to assess the potential of MHD and the work is described which has demonstrated the feasibility of efficient low cost-seed recovery employing vapor phase separation. Superconducting field coils appear to be essential for commercial MHD power generation. The "stabilized" principle of constructing such coils is described. Using this principle it is possible to operate a large coil on the H–I curve of a short sample of wire. This development reduces the construction of large superconducting coils to an engineering problem. (auth)

37229 THE PROSPECTS FOR CLOSED CYCLE MPD POWER GENERATION. Lindley, B. C. (C. A. Parsons and Co. Ltd., Newcastle upon Tyne, Eng.); McNab, I. R.; Dunn, P. D. Phil. Trans. Roy. Soc. London, Ser. A, 261: 368-93(July 6, 1967).

The basic features of closed cycle MPD systems are described, introducing the three main combination cycles (direct nuclear, indirect nuclear, indirect fired) which could be adopted for commercial power stations. Because of the high temperatures and attendant problems associated with thermal ionization of the working gas plasma, emphasis is placed upon achieving nonequilibrium ionization. This phenomenon is generally applicable only in closed-cycle systems employing certain gases as the working fluid: the basic theory and required operating parameters of several techniques for inducing nonequilibrium ionization are reviewed. Matching a heat source, whether based on combustion or nuclear energy, to the MPD stage imposes a number of restrictions. Nuclear reactors to provide temperatures suitable for MPD systems (perhaps up to 1800°C) have yet to be developed, but design criteria can be formulated. Cycle studies to specify operating parameters (including temperature, pressure, associated steam cycle, etc.) are presented. The technical feasibility of an indirect-fired heat exchanger is considered. Overall system performance, development time scale and incentives are also examined. In the United Kingdom, experimental research and development towards closed cycle MPD power generation is mainly in progress at International Research and Development Co. Ltd and at A.E.R.E., Harwell. Details of the programs are given and achievements in terms of experimental data are presented. Finally, the prospects for closed-cycle MPD power generation are reviewed. (auth)

37230 THE PROSPECTIVE ECONOMICS AND THERMAL EFFICIENCY OF LARGE SCALE OPEN CYCLE MHD STATIONS. Kirillin, V. A.; Rossievskii, G. I.; Styrikovitch, M. A.; Scheindlin, A. E. (High Temperature Inst., Moscow). Phil. Trans. Roy. Soc. London, Ser. A, 261: 394-400(July 6, 1967).

The overall thermal efficiency of several different fossil-fueled power stations is discussed using an MHD generator and the conventional method of preheating the combustion with exhaust gases from the generator. Air preheat temperatures of between 1300 and 1700°C are considered when overall efficiencies of 51 and 61% may be attained. If the generator length is to be restricted to between 10 and 15 m in order to limit duct heat losses, magnetic fields of 4 to 6 Wb/m^2 are required. The use of oxygen enrichment is found at present to be uneconomic but reacting methane with steam (an endothermic reaction) to give the fuel to be burnt is an attractive alternative process although not as good thermodynamically as air preheating. Economic considerations indicate that MHD may only be useful for high-cost fuels. (auth)

37231 FIRST RESULTS OF THE ELECTRICITE DE FRANCE 8 MW MHD EXPERIMENTAL RIG AT CENTRE DE RECHERCHES ET D'ESSAIS DES RENARDIERES. Pericart, J.; de Montardy, A. (Electricite de France, Paris). Phil. Trans. Roy. Soc. London, Ser. A, 261: 401-18(July 6, 1967).

During its first year of service the MHD experimental rig at Renardieres was used for various studies on the performance of different-sized MHD generators and of the technology of electrodes and insulating walls. However, these experiments are not yet finished. The present state of the most interesting studies is described. The results are compared with those published by other research teams. The characteristics of the experimental plant and the conditions under which MHD experiments have been carried out are described. Changes in the electrical and physical conditions of ionized gases during their passage through the test

section were studied, as a knowledge of these conditions is necessary for the correct interpretation of conditions in full-size MHD generators. Studies on MHD generator materials include insulating walls, "hot" electrodes and "cold" electrodes. However, only the studies on "cold" electrodes are reported in detail as they are the most advanced to date; the studies on "hot" electrodes have not progressed far, and for insulating walls, the use of cold "peg walls" developed by Avco was adopted. Finally some results of studies on generator operation are discussed. (auth)

37232 TEMPERATURE AND VELOCITY MODULATED MHD SYSTEMS. Ibberson, V. J. (London Univ.); Harris, D. Phil. Trans. Roy. Soc. London, Ser. A, 261: 429-39(July 6, 1967).

A study is made of the means by which plasmas used for generating MHD power may be modulated in order to provide higher power densities. Temperature and/or velocity modulation may be obtained in a quasi-steady flow combustion system, e.g., by introducing striations of high-temperature fluid, or in a nonsteady system by exciting pulsations or oscillations. Studies on striations are outlined and the relevant work on nonsteady modulation is discussed. A description is given of the joint work at Sheffield University on an oscillatory vortex MHD generator (Sheffield) and a proposed linear MHD system (Queen Mary College, London). (auth)

37233 LEAKAGE CURRENTS IN A SEGMENTED ELECTRODE GENERATOR. Haines, M. G. (Imperial Coll. of Science and Tech., London. International Research and Development Co. Ltd., Newcastle upon Tyne, Eng.). Phil. Trans. Roy. Soc. London, Ser. A, 261: 440-54(July 6, 1967).

Segmented electrodes are being used extensively in magnetohydrodynamic flow experiments in order to overcome the high impedance present in a continuous electrode system when the plasma has a high Hall coefficient. Until recently the theoretical study of a segmented system has artificially constrained the current to flow directly across the duct. Since this work was undertaken Witalis has investigated the onset of shorting of the Hall voltage between adjacent segments by leakage currents due to insufficiently long insulator sections, by assuming that the segmentation length is much smaller than the duct width. Three methods for analyzing the effect of leakage currents and obtaining the electrical characteristics are reported. These are conformal mapping, Fourier series, and an approximate equivalent circuit. Only the Fourier analysis method requires no further assumptions other than periodicity and it reproduces Witalis's criterion for shorting when his additional assumptions apply. The equivalent circuit method is easier to apply and will be more useful for a practical nonuniform duct. (auth)

37234 FLOW OF CURRENT IN A CROSS CONNECTED MHD GENERATOR WITH FOUR ELECTRODES. Nemkova, N. G.; Alavidze, G. R. (High Temperature Inst., Moscow). Phil. Trans. Roy. Soc. London, Ser. A, 261: 455-60(July 6, 1967).

The current flow patterns in an MHD generator with four electrodes are derived. There are two electrodes each side of the duct; the upstream one on the cathode side is connected to the downstream one on the anode side and a load across the other pair of electrodes produces a rudimentary cross-connected generator. The fluid properties, flow conditions and magnetic field are supposed uniform across the duct and a two-dimensional analysis is made. A Schwarz–Christoffel transformation is employed to find potential and current distributions. Three simultaneous linear equations must be solved to give explicit equations for currents and potentials. The method is extendable to the case of more electrodes. (auth)

37235 WAVE GROWTH IN MHD GENERATORS. Heywood, J. B. (Central Electricity Research Labs., Leatherhead, Eng.); Wright, J. K. Phil. Trans. Roy. Soc. London, Ser. A, 261: 461-70(July 6, 1967).

It has been shown that in an MHD generator, acoustic waves can grow due to the coupling of fluctuations in electrical conductivity, Hall parameter, and thermodynamic properties of the gas, and with the ohmic dissipation and electromagnetic body forces. A new analysis of this phenomenon is presented in which waves traveling at an arbitrary angle to the flow direction in a plane perpendicular to the magnetic field are considered. In contrast to McCune's (1964) treatment the thermodynamic properties are not restricted to perfect gas laws; and the condition for spatially and temporally growing waves is examined using a general dispersion relation which includes both these types of wave. The following are considered in detail: (i) stationary waves in supersonic flow, and (ii) traveling waves in the subsonic flow found in the C.E.G.B. 200-MW thermal input generator being built at Marchwood, and a possible power station MHD generator. It is found that the waves in the 200-MW rig which burns kerosene in oxygen will be damped. But in an oil–air combustion products generator, for Hall parameters of order 3 or greater, it is found that stationary waves which grow rapidly may occur at Mach numbers greater than about 1.7; and in subsonic flow waves propagating antiparallel to the steady current vector may be amplified, though the growth rate is not excessive. In noble-gas MHD generators these waves are more unstable than in the oil, air combustion products generator. (auth)

37236 EQUILIBRIUM AND NONEQUILIBRIUM ELECTRICAL CONDUCTIVITY OF SEEDED COMBUSTION PRODUCTS. Freck, D. V. (Central Electricity Research Labs., Leatherhead, Eng.). Phil. Trans. Roy. Soc. London, Ser. A, 261: 471-85 (July 6, 1967).

From measurements by four-electrode and microwave techniques and from theoretical calculations, the conclusions are drawn that the equilibrium electrical conductivity varies with fuel/air ratio, being higher in fuel-rich conditions, and that the chlorine and sulfur impurities in power station fuels will not significantly affect the conductivity under MHD generator conditions. Experiments on nonequilibrium conductivity in seeded combustion products at 1500°K are described. The form of the current-field curve at high values of the ratio of electrical field to molecule density was investigated. At a certain value of the field the current was found to increase many times above the equilibrium value, with little increase in field. To describe these results, a theory is presented in which ionization by electrons having energies greater than the ionization potential is balanced by a three-body recombination process involving electrons, positive potassium ions, and neutral molecules. This gives a current-field curve of the same shape as that experimentally observed but the experimental value of the field at which the current rises differs from the theoretical value by about 25%. The use of this nonequilibrium conductivity in generators is discussed. (auth)

37237 COMPOSITION AND THERMODYNAMIC PROPERTIES OF COMBUSTION PRODUCTS OF METHANE CONTAINING POTASSIUM CARBONATE. Yungman, V. S.; Gurvich, L. V.; Rtishcheva, N. P. (High Temperature Inst., Moscow). Phil. Trans. Roy. Soc. London, Ser. A, 261: 486-9(July 6, 1967).

Calculations and some computations of the composition of combustion products of methane and oxygen-enriched air between 1000 and 4000°K are described. The effect of introducing potassium into the mixture is considered. This gives rise to the presence of electrons in large quantities and to certain redistributions in the proportions of some compounds and, at different temperatures, to the formation of a variety of potassium compounds. The formation of those compounds has a considerable effect on the concentration of electrons. (auth)

37238 AN EXPERIMENTAL STUDY OF GAS BORNE SUSPENSIONS OF THERMIONIC EMITTERS AS MHD WORKING FLUIDS. Waldie, B.; Fells, I. (Univ. of Newcastle upon Tyne, Eng.). Phil. Trans. Roy. Soc. London, Ser. A, 261: 490-5(July 6, 1967).

The use of gaseous suspensions of thermionically emitting particles as alternatives to alkali-metal-seeded gases for use as MHD working fluids is discussed briefly. Theoretical relations proposed by Sodha & Bendor (1964) are used to show that suspensions of barium oxide in argon can have significantly higher electrical conductivities than thermally ionized cesium–argon mixtures at temperatures below about 2000°K. This advantage is emphasized at pressures above atmospheric pressure. Experimental studies to check the theoretically predicted conductivities are described. A technique has been developed for the preparation of submicron suspensions of barium oxide and other alkali earth oxides in inert gases. A suspension of barium oxide particles in argon has been shown to have a conductivity of 0.1 mho/m at atmospheric pressure and 1600°K. This value is low, because of the relatively large average particle size, 0.3 μm diameter, but is of the same order as the theoretical conductivity for the experimental conditions. (auth)

37239 THE BEHAVIOR OF VARIOUS ELECTRODES AND INSULATORS IN AN EXPERIMENTAL MHD GENERATOR. Devime, R. (Institut Francais du Petrole des Carburants et Lubrifiants, Paris); Lecroart, H.; Porte, R.; Yerouchalmi, D. Phil. Trans. Roy. Soc. London, Ser. A, 261: 496-503(July 6, 1967).

The special features of an MHD generator in which there is an electrically produced temperature modulation of the gas stream are discussed. Methods and equipment for producing a striated plasma are described together with the first experimental apparatus (MHD 5) used to study such flows. A critical examination of the materials employed in the first series of experiments lead to the conclusion that hot electrodes were most suitable and indicated other aspects which would need further study. The limitations of the MHD 5 duct lead to the design of MHD 6 and the gas conditions,

geometric dimensions, duct rigidity, thermal expansion problems, material compatibility and heat transfer of this equipment are discussed in some detail. (auth)

37240 NEW CERAMICS BASED ON MONOCLINIC ZIRCONIA. Anthony, A. M. (CNRS, Bellevue, France); Yerouchalmi, D. Phil. Trans. Roy. Soc. London, Ser. A, 261: 504-13(July 6, 1967).

In MHD generators the mechanism of electrical conductivity of the electrodes should be electronic with a value of about 100 mho/m at 2000°K. In addition, the material should have good thermal shock resistance. Calcia- or yttria-stabilized zirconia have sufficiently good electrical conductivity and thermal shock resistance but since their conduction mechanism is ionic they are spoiled by the passage of direct current because of electrolysis. The conductivity of pure monoclinic zirconia is mainly electronic and at 2000°K has a value of about 50 mho/m but this declines very sharply as the temperature falls. Also the phase change at 1500°K from a monoclinic to tetragonal form with a concomitant volume shrinkage of 9% is mechanically destructive and precludes the use of this material for making electrodes. A new ceramic material has been designed to overcome these difficulties. A combination of zirconia, a second ceramic (which may be an insulator) and a metal is used. The metal provides electrical conductivity below 1800°K; the second ceramic material acts as a diluent to the zirconia and reduces the effect of the phase change at 1500°K sufficiently to prevent mechanical failure of the material, while the zirconia itself provides the hot electrode surface and the electrical conduction at the high temperature. (auth)

37241 AIR HEATERS AND SEED RECOVERY FOR MHD PLANT. Horn, G. (Central Electricity Generating Board, London); Sharp, A. W.; Hryniszak, W. R. Phil. Trans. Roy. Soc. London, Ser. A, 261: 514-40(July 6, 1967).

The only economic way of producing sufficiently high flame temperature for MHD power generation using fossil fuels is to burn them with air preheated to at least 1200°C. The factors affecting the design of suitable air heaters for the high-temperature stage of this process are discussed and the features of three general types will be described. One of these is a completely novel concept in which a circulating stream of molten material is used to transfer heat between hot combustion products and air. Experiments which are being carried out to provide design data for these three types are described and include: pumping and atomization of high-temperature fluids; testing of suitable refractory materials; aerodynamic model studies; and development of refractory seals. Seeding chemicals introduced to enhance gas conductivity pose special problems of corrosion and deposition in the air heaters and investigations into the interdependent processes of heat and mass transfer will be described. Since the seed cannot be allowed to escape from the system, studies of recovery processes are included. (auth)

37242 SOME ASPECTS OF THE CHEMISTRY OF MHD SEED. Hart, A. B.; Laxton, J. W. (Central Electricity Research Labs., Leatherhead, Eng.). Phil. Trans. Roy. Soc. London, Ser. A, 261: 541-57(July 6, 1967).

Information assembled from the literature and from experiments about the physical chemistry of potassium sulfate at high temperatures is reported. This enables a first assessment to be made of the difficulty of evaporating it quickly in an MHD combustion chamber and recovering it after it leaves the generator duct. Measurements of the evaporation rate show that in oxidizing and neutral gases a 50-μm diameter particle, which could be produced by normal powdering methods, should be evaporated within 10 to 20 ms at 2800°K and this agrees with calculations. The experiments suggest that evaporation should be much faster in reducing gases. Available thermodynamic data have been used to determine the amount of heat used in evaporation of the seed. It amounts to 6.9% of the calorific value of oil fuel, allowing for seed impurities. A flue gas containing 0.7 at. % of potassium should begin to condense at 1600°K and the amount of liquid, solid, or smoke formed will depend on the rate of removal of heat from the flue gas and on the saturated vapor pressure of K_2SO_4. Accurate data for the latter determined by effusion and transpiration methods are reported. Potassium sulfate reaching metal tubes in the boiler and superheater may form liquids with excess of sulfur trioxide (including pyrosulfates, melting at about 670°K) in the temperature range 670 to 970°K. This could cause more severe corrosion than when potassium is absent. Measurements of the partial pressure of potassium sulfate in equilibrium with coal ash slags up to 2000°K suggest that it should be possible to reject the slag without loss of potassium if it could be separated from the potassium containing gas at 2000 to 2100°K according to the ash content of the coal. (auth)

37243 SUPERCONDUCTING MAGNETS FOR MHD GENERATORS. Chester, P. F. (Central Electricity Research Labs., Leatherhead, Eng.). Phil. Trans. Roy. Soc. London, Ser. A, 261: 558-75(July 6, 1967).

A review is presented of the science and technology of superconducting magnets and the possibility of their application in large MHD generators. The newly exploited hard superconductors offer, in principle, the most economic means of providing magnetic fields of several tens of kilo-oersteds over large volumes. Unfortunately these materials have exhibited certain peculiarities of behavior when wound into coils ("training" and "degradation") which, until recently, had made it impossible to realize their full potential or to design larger coils with any confidence. The reasons for this are now fairly well understood and are seen to be fundamental to hard superconductors. A number of techniques have been developed to reduce these effects, the most recent, involving the intimate combination of the superconductor with a metal of low resistivity together with the provision of adequate cooling, circumvents the problem completely. A further problem with large superconducting magnets is to protect the windings, in the event of a coolant failure, against destruction by the release of the stored magnetic energy, 10^{10} J in the case of a large MHD generator magnet. It will be shown that this also dictates the use of composite conductors in which the superconductor is the minor component. Although a number of detailed problems of cryogenic engineering remain to be solved, it is now possible to design windings for large superconducting magnets that will operate predictably, safely, and at the full potential of the superconductor. (auth)

37244 MAGNETOHYDRODYNAMIC POWER SYSTEMS. Elliott, David G. (Jet Propulsion Lab., Pasadena, Calif.). J. Spacecraft Rockets, 4: 842-6(July 1967).

A discussion of magnetohydrodynamic power conversion is given. The main topics are liquid-metal MHD systems and plasma MHD systems. (M.O.W.)

37245 THERMIONIC SPACE POWER SYSTEMS REVIEW. Becker, R. A. (General Electric Co., Pleasanton, Calif.). J. Spacecraft Rockets, 4: 847-51(July 1967).

The current status of thermionic technology and its applications is reviewed. Solar thermionic generators, isotope-heated thermionic power systems, and nuclear reactor thermionic systems are discussed. (M.O.W.)

37246 THERMOELECTRIC CELL AND REACTOR. (to U.S. Atomic Energy Commission). French Patent 1,239,488. July 18, 1960. Priority date Oct. 1, 1958, United States.

Thermionic cells are described in which an emitter and a collector electrode are separated by a Cs plasma. A particular embodiment is constituted by a thermionic nuclear fuel element in which a number of said cells are connected in series, the emitter electrodes therein being formed by units of (U,Zr)C and Ta. A Cs container is provided at the bottom of the fuel element and communicates with the interelectrode spaces. (auth)

37247 IMPROVEMENTS RELATING TO TWO-PHASE FLUID POWER GENERATORS WITH NO MOVING PARTS. (to United Aircraft Corp.). British Patent 1,072,400. June 14, 1967. Priority date Dec. 31, 1962, United States.

A two-phase fluid, closed-loop, self-pumping, gravity-free, power generator is described. The generator has no moving parts and, therefore, has low mechanical noise level, has low vibration level, uses neither bearings nor seals, has high-temperature capability with low weight, low volume, and high efficiency, and has great potential for long periods of unattended operation. (M.O.W.)

37248 METHOD OF REMOVING ALKALI MATERIAL FROM HOT GAS. (to Avco Corp.). British Patent 1,071,797. June 14, 1967. Priority date Oct. 14, 1963, United States.

A method useful in the recovery of alkali materials (seed) added to ionize products of combustion produced from burning coal in air or an oxygen-enriched combustible medium is described. The seed can be recycled and reused within an MHD electrical generating system. (M.O.W.)

37249 MAGNETOHYDRODYNAMIC GENERATING SYSTEM. (to Westinghouse Electric Corp.). British Patent 1,078,332. Aug. 9, 1967. Priority date Oct. 23, 1963, United States.

The generating ducts and magnet arrangements for a magnetohydrodynamic generating system are described. (M.O.W.)

37250 METHOD AND DEVICE FOR SUPPLYING A MAGNETOHYDRODYNAMIC GENERATOR. Karr, Claude (to Commissariat a l'Energie Atomique). British Patent 1,078,162. Aug. 2, 1967. Priority date Feb. 8, 1964, France.

The design and operation of a device for supplying an MHD generator are described. The primary application is to MHD generators in which the conducting fluid consists of a mixture of a hot carrier gas produced by combustion with a small proportion of

elements which can readily be ionized and which are usually alkaline. (M.O.W.)

37251 THERMIONIC ENERGY CONVERTERS. (to Brown, Boveri and Cie, Aktiengesellschaft). British Patent 1,081,778. Aug. 31, 1967. Priority date July 3, 1964, Germany.

A thermionic energy converter is described, in which the thermal energy generated by a nuclear fission is fed to an electrically conductive electron emitter in thermal communication with the nuclear fuel. Several configurations are suggested including the following: a cylindrical emitter provided with longitudinal bores for insertion of nuclear fuel, an emitter in which nuclear fuel is embedded in the form of tablets, a cylindrical emitter having the inside wall coated with nuclear fuel, and a homogeneous mixture of emitter and nuclear fuel. Appropriate dimensions for each configuration are suggested. (A.G.W.)

37252 MAGNETOHYDRODYNAMIC (MHD) GENERATOR. (to Kernforschungsanlage Julich Des Landes Nordrhein-Westfalen e.V.). British Patent 1,081,191. Aug. 31, 1967. Priority date Apr. 16, 1964, Germany.

The MHD generator described includes a curved duct through which a conductive fluid from which electrical energy is to be extracted flows longitudinally. Curved electrodes are disposed on one pair of opposite walls of the duct and face one another across its width. A magnetic flux generator produces lines of magnetic flux substantially perpendicular to the direction of fluid flow through the duct. When the duct is designed in the shape of a coil, savings of space and materials are expected to result. Preferably a superconducting material is used for the magnet coils. (A.G.W.)

37253 MAGNETOHYDRODYNAMIC GENERATORS. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 1,079,254. Aug. 16, 1967. Priority date Sept. 26, 1963, Germany.

A channel arrangement for an MHD generator is described, in which the walls that bound the flow space are made of thermally conductive material the melting point of which is substantially higher than Cu and for which the quotient $\lambda/\alpha E \geq 4.0 \times 10^{-2}$ cm^2/sec, where λ is the thermal conductivity, E is the modulus of elasticity, and α is the coefficient of linear expansion of the material at room temperature. The material may be, for example, sintered metals or nonmetallic inorganic materials such as electrically conductive SiC or BeO. Cooling for the walls is provided, but the temperature is maintained not substantially less than 1000°C. The walls may be made in parts joined together by layers of electrically insulating refractory cement. (A.G.W.)

Fluid Physics

Refer also to abstracts 36218, 37301, and 37421.

37254 (AD-650639) THE EFFECT OF TRANSVERSE ION CURRENT ON THE FLOW OF AIR IN A FLAT DUCT. Pejack, E.; Velkoff, H. (Ohio State Univ. Research Foundation, Columbus). Feb, 1967. Contract DA-31-124-ARO(D)-246. 84p. (AROD-4942:2-E). CFSTI.

Friction factors, velocity distributions, pressure gradients, and density measurements were made on a $\frac{5}{8}$-inch × 5-inch rectangular flow channel with air flow. A plane of corona wires along the midplane of the channel was the source of ions which drifted across the air flow to the electrically grounded walls of the channel. Experimental data were collected to determine the influence of the ion flow on the air flow and the extent of the ion-fluid coupling. The electrodynamic and hydrodynamic equations were set up and several approximate solutions were obtained based on the postulation of a flow-induced body force and the assumption of fully established, one-dimensional flow. The magnitude of the ion effects was found to be significantly dependent on the ion density distribution within the flow channel. (auth) (TAB)

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37256 (AD-651034) FULLY DEVELOPED MAGNETOGASDYNAMIC FLOW BETWEEN DIVERGING PLANE WALLS. Final Report. Snyder, William T.; Maus, James R. (Tennessee Univ., Tullahoma. Space Inst.). Apr. 1967. Contract AF 40(600)-1113. 123p. (AEDC-TR-67-80). CFSTI.

A solution was obtained to the magnetogasdynamic equations of motion including the effects of compressibility, viscosity, thermal conductivity, and crossed electric and magnetic fields. The solution obtained is valid for an acceleration flow in which a separation of variable form of solution is utilized. The constraints under which a separable solution is valid are clearly delineated. The solution is an exact solution in the sense that no terms were dropped from the governing equations and boundary layer approximations were not employed. The results of the investigation were presented in the form of velocity and temperature profiles for several values of electromagnetic parameters. Although the mathematical model used in the present investigation is too crude to be utilized for detailed design of a practical MHD accelerator, it is believed, nevertheless, that the model displays certain qualitative features of the flow which are likely to be encountered in a practical device. (auth) (TAB)

37257 (ARL-67-0046) VARIABLE CONDUCTIVITY FULLY DEVELOPED MHD CHANNEL FLOW. Kieffer, Paul C. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. Dept. of Mechanical Engineering). Mar. 1967. 62p. CFSTI.

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The thermal instability of an incompressible fluid sphere heated internally is considered, when the fluid absorbs and emits thermal radiation. Two asymptotic cases of the radiative transfer equation, namely, when the fluid is optically thin and optically thick, were

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The differential effects of shock fronts on a magnetic field were effectively determined and consequently the expressions for the curvature and torsion of magnetic lines behind an unsteady magnetogasdynamic shock wave were obtained. (auth)

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Results are presented of heat-transfer research in electrolytes at large Hartman numbers (up to Ha = 10). The tests were made in a rectangular channel in the presence of a transverse magnetic field. The test equipment is described in detail. To display the magnetic effects clearly, the heat exchange measurements were made alternately without a field and with the magnetic field applied. The data were reduced by means of a digital computer. A connection is established between the decrease in the heat exchange, due to the application of the magnetic field, and the value of the critical Reynolds number. It is shown, that the decrease in the heat exchange density in the case of a turbulent magnetohydrodynamic stream can be characterized by the ratio Ha^2/Re. (the Stuart parameter). An empirical formula is obtained for the variation of the Nusselt number with the Stuart number. The range of applicability of the results is discussed. (ATD)

37263 A GENERALIZATION OF THE KAPUR-SHUKLA PROBLEM. Dinu, L. I. (Inst. of Mathematics, Bucharest). Stud. Cercet. Mat., 18: 1573-7(1966). (In Rumanian).

J. N. Kapur and J. B. Shukla examined the exponentially nonstationary problem of the unsteady flow of two incompressible and immiscible fluids between two infinite, plane-parallel walls. The problem was further extended by assuming that a transversal magnetic field is also applied. The interface separating the two fluids was chosen to coincide with the axis oriented in the direction of the movement of the fluids. Expressions were derived for the pressure gradient, introducing the magnetic, kinematic, and dynamic viscosities into the equations. The formulas obtained make it possible to calculate the magnetic field and the flow rate. (TTT)

37264 HYDROMAGNETIC LAMINAR FLOW THROUGH CONDUCTING PARALLEL POROUS WALLS. Reddy, P. Govinda; Jain, M. K. (Indian Inst. of Tech., New Delhi). J. Phys. Soc. Jap., 22: 1255-66(May 1967).

The steady-state solution for the laminar flow of an electrically conducting liquid in the presence of a transverse magnetic field has been investigated in detail. The porosity of the walls was taken into account in obtaining the velocity profiles for the induced magnetic and electric fields. Consideration was also given to the rectangular channels in the following two cases: (a) when the total current is zero and (b) when the total current is not zero. It is found that the general solution contains two unknown constants. By properly choosing these constants it is shown that the same general solution can be made to fit the solutions of two-dimensional channels whose geometry approaches in the limit to that of the one-dimensional channel. (auth)

37265 CONSTRUCTION OF MHD DUCT WALL PROFILE. Kozyrenko, V. E. Magnit. Gidrodin., No. 4, 150-1(1966). (In Russian).

The interelectrode portion of a plane, linear magnetohydrodynamic duct is sufficiently far removed from the edge of the electrodes that the electrode effects may be neglected. The flow within a plane duct with ideally conducting walls was used as a mathematical model for designing and studying the system. It was assumed thereby that the flow along the equipotential field follows the walls in the direction of the symmetry axis of the duct. A formula was derived for the unequivocal determination of the shape of the duct. Similar calculations may be carried out for flows with axial symmetry, under consideration of the viscosity and the heat conductivity of the gas. (TTT)

37266 EXPERIMENTAL INVESTIGATION OF TURBULENT FLUID PIPE FLOW IN THE PRESENCE OF LONGITUDINAL MAGNETIC FIELD. Levin, V. B.; Chislenkov, I. A. Magnit. Gidrodin., No. 4, 147-8(1966). (In Russian).

Values of the hydraulic resistance were determined during flow of liquid gallium metal in a tube with a diameter d = 20 mm in a longitudinal magnetic field having an inductance up to 3 weber/m^2, which corresponds to a range of Hartman numbers ($Ha = Bd\sqrt{\sigma/\mu}$) up to 2300. The flow rate of the gallium metal was held constant on applying the magnetic field. The pressure gradient was measured over a length of 1.8 m with ten measurements of the static pressure. The metal temperature was measured at the inlet and exit from the solenoid creating the magnetic field. The hydraulic resistance coefficient λ is given as a function of the Ha number at Reynolds numbers of 41,600, 46,700, and 50,500. All the experimental curves show a characteristic point of inflection, where the decrease in hydraulic resistance levels off under the action of the longitudinal magnetic field. The following formula, which approximates the experimental data, has no point of inflection, and can be used only in the region where the effect of the magnetic field on the resistance has leveled out: $\lambda = 0.3164\,Re^{-0.25}(1 - 37.7\,Ha^{1.65}/Re^{1.45})$. (TTT)

37267 TURBULENT FLOW IN ROUGH CONDUITS IN PRESENCE OF TRANSVERSE MAGNETIC FIELD. Branover, G. G.; Gel'fgat, Yu. M.; Dukure, R. K. Magnit. Gidrodin., No. 4, 148-50(1966). (In Russian).

The effect of the size and shape of protrusions of roughness on the resistance coefficient was investigated during turbulent flow in tubes of rectangular cross-section. The analysis was carried out in the following form: (1) $\lambda = \lambda_0(1 + \gamma N)$. Here N is Stewart's number equal to $\sigma B^2 R/\rho v$, where R is the ratio of the cross-sectional area to the perimeter and v is the average flow rate. Here γ is a numerical coefficient, and λ_0 is the resistance coefficient of the tube in the absence of a magnetic field. The experiments were run on tubes having various types of protrusions (disks, alternating zone of roughness, etc.). The value of γ in formula 1 does not depend on the relative roughness, but is determined only by the form and position of the protrusions. The data can be used in design calculations. (TTT)

37268 CONDUCTING LIQUID FLOW IN RECTANGULAR PIPES IN THE PRESENCE OF ORTHOGONALLY ORIENTED MAGNETIC FIELD. Branover, G. G.; Vasil'ev, A. S.; Gel'fgat, Yu. M. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 2, 43-6(1967). (In Russian).

New experimental results of magnetohydrodynamic turbulent flow in the presence of magnetic fields orthogonal to the flow plane are dealt with. Empirical formulas for the friction coefficient calculation, valid for rectangular pipes with various aspect ratios, are presented. (auth)

37269 TURBULENT MHD JET FLOW IN FINITE SPACE. Branover, G. G.; Gel'fgat, Yu. M.; Shcherbinin, E. V. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 2, 47-53(1967). (In Russian).

An experimental investigation of MHD jet flow in a finite space was carried out. The flow in the presence of a transverse magnetic field was reconstructed, and its changes due to the duct wall conductivity were established. (auth)

37270 EFFECTS OF LONGITUDINAL MAGNETIC FIELD ON THE FLOW IN A TUBE. Gurfink, M. M. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza, No. 3, 40-2(May-June 1967). (In Russian).

Studies were made of turbulent conducting fluid flow in a round cylindrical tube in a homogeneous longitudinal magnetic field. It was found, that under given conditions, the influence of the magnetic field was limited by the appearance of a corresponding mechanism of dissipation, which was taken into account by introducing one empirical constant. Equations were developed for the coefficient of hydraulic resistance and for the mean velocity distribution. (R.V.J.)

37271 AN INTRODUCTION TO MAGNETO-FLUID MECHANICS. SECOND EDITION. Ferraro, V. C. A.; Plumpton, C. New York, Oxford University Press, 1966. 261p. $5.00.

Topics covered are: introduction and fundamental equations, magnetostatics and steady states, magnetohydrodynamic waves, hydromagnetic shock waves, stability, turbulence, motion of a charged particle in a magnetic field, dynamics of a plasma, and waves in a plasma. (M.H.R.)

37272 ELECTRODYNAMICS OF MOVING MEDIA. Penfield, Paul Jr.; Haus, Hermann A. Research Monograph No. 40. Cambridge, Mass., Massachusetts Institute of Technology Press, 1967. 286p. $12.50.

Experiments have not been successful in resolving the controversy about the correctness of several apparently different electrodynamic formulations for moving media because many of the differences concern small relativistic effects. The resolution had to come from more complete theoretical understanding. It has been found that none of the force expressions is complete; all must be modified and, when so modified, are in agreement. This conclusion came from a careful identification of the energies and powers, and by establishing a law of conservation of energy consistent with thermodynamics, continuum mechanics, and special

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Results are presented of heat-transfer research in electrolytes at large Hartman numbers (up to Ha = 10). The tests were made in a rectangular channel in the presence of a transverse magnetic field. The test equipment is described in detail. To display the magnetic effects clearly, the heat exchange measurements were made alternately without a field and with the magnetic field applied. The data were reduced by means of a digital computer. A connection is established between the decrease in the heat exchange, due to the application of the magnetic field, and the value of the critical Reynolds number. It is shown, that the decrease in the heat exchange density in the case of a turbulent magnetohydrodynamic stream can be characterized by the ratio Ha^2/Re. (the Stuart parameter). An empirical formula is obtained for the variation of the Nusselt number with the Stuart number. The range of applicability of the results is discussed. (ATD)

37263 A GENERALIZATION OF THE KAPUR-SHUKLA PROBLEM. Dinu, L. I. (Inst. of Mathematics, Bucharest). Stud. Cercet. Mat., 18: 1573-7(1966). (In Rumanian).

J. N. Kapur and J. B. Shukla examined the exponentially nonstationary problem of the unsteady flow of two incompressible and immiscible fluids between two infinite, plane-parallel walls. The problem was further extended by assuming that a transversal magnetic field is also applied. The interface separating the two fluids was chosen to coincide with the axis oriented in the direction of the movement of the fluids. Expressions were derived for the pressure gradient, introducing the magnetic, kinematic, and dynamic viscosities into the equations. The formulas obtained make it possible to calculate the magnetic field and the flow rate. (TTT)

37264 HYDROMAGNETIC LAMINAR FLOW THROUGH CONDUCTING PARALLEL POROUS WALLS. Reddy, P. Govinda; Jain, M. K. (Indian Inst. of Tech., New Delhi). J. Phys. Soc. Jap., 22: 1255-66(May 1967).

The steady-state solution for the laminar flow of an electrically conducting liquid in the presence of a transverse magnetic field has been investigated in detail. The porosity of the walls was taken into account in obtaining the velocity profiles for the induced magnetic and electric fields. Consideration was also given to the rectangular channels in the following two cases: (a) when the total current is zero and (b) when the total current is not zero. It is found that the general solution contains two unknown constants. By properly choosing these constants it is shown that the same general solution can be made to fit the solutions of two-dimensional channels whose geometry approaches in the limit to that of the one-dimensional channel. (auth)

37265 CONSTRUCTION OF MHD DUCT WALL PROFILE. Kozyrenko, V. E. Magnit. Gidrodin., No. 4, 150-1(1966). (In Russian).

The interelectrode portion of a plane, linear magnetohydrodynamic duct is sufficiently far removed from the edge of the electrodes that the electrode effects may be neglected. The flow within a plane duct with ideally conducting walls was used as a mathematical model for designing and studying the system. It was assumed thereby that the flow along the equipotential field follows the walls in the direction of the symmetry axis of the duct. A formula was derived for the unequivocal determination of the shape of the duct. Similar calculations may be carried out for flows with axial symmetry, under consideration of the viscosity and the heat conductivity of the gas. (TTT)

37266 EXPERIMENTAL INVESTIGATION OF TURBULENT FLUID PIPE FLOW IN THE PRESENCE OF LONGITUDINAL MAGNETIC FIELD. Levin, V. B.; Chislenkov, I. A. Magnit. Gidrodin., No. 4, 147-8(1966). (In Russian).

Values of the hydraulic resistance were determined during flow of liquid gallium metal in a tube with a diameter d = 20 mm in a longitudinal magnetic field having an inductance up to 3 weber/m^2, which corresponds to a range of Hartman numbers ($Ha = Bd\sqrt{\sigma/\mu}$) up to 2300. The flow rate of the gallium metal was held constant on applying the magnetic field. The pressure gradient was measured over a length of 1.8 m with ten measurements of the static pressure. The metal temperature was measured at the inlet and exit from the solenoid creating the magnetic field. The hydraulic resistance coefficient λ is given as a function of the Ha number at Reynolds numbers of 41,600, 46,700, and 50,500. All the experimental curves show a characteristic point of inflection, where the decrease in hydraulic resistance levels off under the action of the longitudinal magnetic field. The following formula, which approximates the experimental data, has no point of inflection, and can be used only in the region where the effect of the magnetic field on the resistance has leveled out: $\lambda = 0.3164 Re^{-0.25}(1 - 37.7\, Ha^{1.65}/Re^{1.45})$. (TTT)

37267 TURBULENT FLOW IN ROUGH CONDUITS IN PRESENCE OF TRANSVERSE MAGNETIC FIELD. Branover, G. G.; Gel'fgat, Yu. M.; Dukure, R. K. Magnit. Gidrodin., No. 4, 148-50(1966). (In Russian).

The effect of the size and shape of protrusions of roughness on the resistance coefficient was investigated during turbulent flow in tubes of rectangular cross-section. The analysis was carried out in the following form: (1) $\lambda = \lambda_0(1 + \gamma N)$. Here N is Stewart's number equal to $\sigma B^2 R/\rho v$, where R is the ratio of the cross-sectional area to the perimeter and v is the average flow rate. Here γ is a numerical coefficient, and λ_0 is the resistance coefficient of the tube in the absence of a magnetic field. The experiments were run on tubes having various types of protrusions (disks, alternating zone of roughness, etc.). The value of γ in formula 1 does not depend on the relative roughness, but is determined only by the form and position of the protrusions. The data can be used in design calculations. (TTT)

37268 CONDUCTING LIQUID FLOW IN RECTANGULAR PIPES IN THE PRESENCE OF ORTHOGONALLY ORIENTED MAGNETIC FIELD. Branover, G. G.; Vasil'ev, A. S.; Gel'fgat, Yu. M. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 2, 43-6(1967). (In Russian).

New experimental results of magnetohydrodynamic turbulent flow in the presence of magnetic fields orthogonal to the flow plane are dealt with. Empirical formulas for the friction coefficient calculation, valid for rectangular pipes with various aspect ratios, are presented. (auth)

37269 TURBULENT MHD JET FLOW IN FINITE SPACE. Branover, G. G.; Gel'fgat, Yu. M.; Shcherbinin, E. V. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 2, 47-53(1967). (In Russian).

An experimental investigation of MHD jet flow in a finite space was carried out. The flow in the presence of a transverse magnetic field was reconstructed, and its changes due to the duct wall conductivity were established. (auth)

37270 EFFECTS OF LONGITUDINAL MAGNETIC FIELD ON THE FLOW IN A TUBE. Gurfink, M. M. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza, No. 3, 40-2(May-June 1967). (In Russian).

Studies were made of turbulent conducting fluid flow in a round cylindrical tube in a homogeneous longitudinal magnetic field. It was found, that under given conditions, the influence of the magnetic field was limited by the appearance of a corresponding mechanism of dissipation, which was taken into account by introducing one empirical constant. Equations were developed for the coefficient of hydraulic resistance and for the mean velocity distribution. (R.V.J.)

37271 AN INTRODUCTION TO MAGNETO-FLUID MECHANICS. SECOND EDITION. Ferraro, V. C. A.; Plumpton, C. New York, Oxford University Press, 1966. 261p. $5.00.

Topics covered are: introduction and fundamental equations, magnetostatics and steady states, magnetohydrodynamic waves, hydromagnetic shock waves, stability, turbulence, motion of a charged particle in a magnetic field, dynamics of a plasma, and waves in a plasma. (M.H.R.)

37272 ELECTRODYNAMICS OF MOVING MEDIA. Penfield, Paul Jr.; Haus, Hermann A. Research Monograph No. 40. Cambridge, Mass., Massachusetts Institute of Technology Press, 1967. 286p. $12.50.

Experiments have not been successful in resolving the controversy about the correctness of several apparently different electrodynamic formulations for moving media because many of the differences concern small relativistic effects. The resolution had to come from more complete theoretical understanding. It has been found that none of the force expressions is complete; all must be modified and, when so modified, are in agreement. This conclusion came from a careful identification of the energies and powers, and by establishing a law of conservation of energy consistent with thermodynamics, continuum mechanics, and special

relativity. Electrostriction, magnetostriction, piezoelectricity, dispersion, and other nonrelativistic effects were taken into account. Two techniques were used to predict force. One is Hamilton's principle. The other is a new technique, the principle of virtual power. This is based on the principle of virtual work but is generalized to apply to continuous media with nonconvection power flow. (W.D.M.)

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Refer also to abstracts 37010, 37028, 37111, 37113, 37114, and 37211.

37273 (AD-650644) DIRECT PROBE MEASUREMENTS IN THE AURORAL IONOSPHERE. Final Report, March 27, 1963-August 1, 1965. Bettinger, Richard T.; Huang, Philip T. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Sept. 1966. Contract AF 19(628)-2792. 38p. (AFCRL-66-825). CFSTI.

Analysis of vehicle potential measurements in a disturbed ionosphere has provided additional information on the rather difficult problem of the plasma-vehicle interaction. The flight data from the Aerobee indicates, that under certain conditions, there exists a rather strong correlation between vehicle potential and the ambient charged particle density. Minimum vehicle potentials (i.e., corrected for the induced effects from current collecting devices) exceeding 2 volts in the region of auroral activity suggests the presence of a high-energy component in the electron energy distribution, 1 eV. Although the vehicle sheath calculations were performed for ideal conditions, they nevertheless indicate that the presence of a high-energy tail enhances the density dependence of the vehicle potential. (TAB)

37274 (AD-650722) STUDIES OF THE IONOSPHERE USING TRANSMISSIONS FROM ACTIVE SATELLITES. Annual Summary Report No. 1, February 1, 1964-January 31, 1966. Koster, John R.; Katsriku, I.; Tete, M. (Ghana Univ., Legon. Dept. of Physics). Aug. 1, 1966. Contract AF 61(052)-800. 100p. (AFCRL-66-814). CFSTI.

The theory of correlation analysis of fading records is reviewed and computer programs given for carrying out the analysis. Continuous observations over a period of 81 days of the 136-Mc signal radiated by "Early Bird" are described. Results include information on diurnal variation of total electron content, and new information on equatorial scintillation and the irregularities giving rise to it. The full correlation analysis of nearly 200 spaced receiver drift measurements made at Tamale, Ghana, is presented. Drifts are westward by day, eastward by night, reversal occurring at about 07.30 and 20.00 GMT. A midmorning maximum of about 200 m/sec is a prominent feature in the F-region drift velocity. Mean F-Region drift velocity is 115 m/sec during the day, and 70 m/sec at night; E-Region velocity is 67 m/sec by day. Correlation ellipses are elongated with axial ratios of about 6 to 1. The total electron content of the ionosphere is studied as determined from observations of the Faraday Rotation of 20-Mc signals radiated by S-66 over a period of 6 months. The diurnal variation of the electron content, and the development of the equatorial anomaly are shown. Refraction effects are shown to seriously affect 20-Mc results at even moderate zenith angles. (TAB)

37275 (AD-650941) THE VARIATION OF AIR DENSITY AT A HEIGHT OF 220 KM IN THE FIRST HALF OF 1966. King-Hele, D. G.; Quinn, Eileen (Royal Aircraft Establishment, Farnborough (England)). Nov. 1966. 14p. (TR-66350). CFSTI.

The changes in the orbit of the satellite Star-rad between January and June 1966 are analyzed to determine the variation in upper-atmosphere density at a standard height (220 km) a little above the satellite's perigee height. It is found that the air density in May-June was about 30% greater than in January-February as a result of the increase in solar activity. The fluctuations in density on a shorter time-scale, 2 to 3 days, are also shown. (auth) (TAB)

37276 (BNWL-SA-1292) MIDLATITUDE AURORAL SPECTRA. Clark, K. C. (Washington Univ., Seattle. Dept. of Physics); Hoch, R. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 29, 1967. Contract AT(45-1)-1830. 25p. (CONF-670631-1). Dep. CFSTI.

From Conjugate Point Symposium, Boulder, Colo.

At Richland, Washington, (L = 2.7) routine patrol spectrograms of auroras in the magnetic meridian, resolving wavelength and elevation angle, were obtained for the 1966-1967 season. With sensitivity adequate for airglow lines, records show sequences of moderately strong auroral spectra on ten nights of high magnetic activity. These displays usually continued over several hours. In each case the region of greatest intensity seemed well to the north, but the emission sometimes extended to the magnetic zenith with diminished intensity. Characteristically, the spectra show increased red/green intensity ratios of the oxygen lines 6300/5577A typical of type A red auroras, and in the most intense cases the hydrogen Hα and Hβ lines are evident. Inversion of the relative intensity of the 4709A (0,2) and 4652A (1,3) first negative nitrogen bands is noted in a case where the nitrogen intensity and oxygen red enhancement are high. Some increase in auroral activity with the solar cycle is suggested by the spectral character and frequency of these displays. However, although this latitude is favorable for their occurrence at sunspot maximum, no spectra of midlatitude monochromatic 6300A stable auroral arcs were observed at Richland in twelve months of observation beginning May 26, 1966. The f/0.95 grating spectrograph is a recent version of the College meridian type, operated at 25Å resolution and 30-minute exposure times. The Richland station is at an elevation of 3560 feet in the Rattlesnake Hills where there is an unobstructed horizon view. Additional photometric equipment is being installed there and a second meridian spectrograph station, north of the present site, is being established to aid in spectroscopic triangulations. (auth)

37277 (CONF-670429-7) AN INVESTIGATION OF PARTICLE PENETRATION INTO THE MAGNETOSPHERE. Scientific Report No. 289. Stevenson, T. E. (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). Feb. 10, 1967. 92p.

From 49th Annual Meeting of American Geophysical Union, Washington, D. C.

A theoretical investigation is made of the trajectory of a solitary charged particle which emanates from free space and is incident at the boundary of an idealized magnetic field. The object is to arrive at some understanding of what is required of the magnetospheric field if charged solar particles, incident at the magnetospheric boundary, are to be prevented from being reflected back out of the magnetospheric cavity. It is shown that reflection always occurs when a charged particle is incident near the equatorial boundary of a static terminated dipole field. Consequently, the Lorentz force equation and Newton's second law are used in an attempt to deduce some static and temporal, nondipolar magnetic field variations required for deep penetration; emphasis is put on the case where the magnetic field gradient is perpendicular to the boundary. Analog simulation and first order theory are then used to demonstrate that a charged particle may enter and penetrate deep within a magnetic field when the magnetic field gradient is not perpendicular to the boundary of the field. The model used is not meant to represent the field near the magnetospheric boundary. Indeed, at the present there is a lack of knowledge of this field on a sufficiently small spatial and time scale. Rather, the analysis is intended to demonstrate the feasibility of direct penetration across the magnetospheric boundary, in the event that the sufficient field variations do occur. (auth)

37278 (ESRO-SP-8) AURORAL AND ASSOCIATED MAGNETOSPHERIC PHENOMENA AT VERY HIGH LATITUDES. Proceedings of the ESRO Colloquium held at Stockholm, 16-18 November 1965. (European Space Research Organization, Paris (France)). 439p. (CONF-651156). Dep.

Papers are presented on various aspects of magnetospheric theories, magnetic measurements, relations between the outer magnetosphere and ionospheric phenomena, particle measurements, and vlf and elf waves in the magnetosphere. The following topics are included: importance of electric fields in the magnetosphere, magnetic storm effects associated with the tail of the magnetosphere, the open magnetospheric model, neutral points on the boundary of the closed magnetosphere, measurements of the magnetic field in the outer magnetosphere and boundary conditions, coupling between the outer magnetosphere and the high-latitude ionosphere, dynamical model of auroral morphology, magnetic field measurements in the high-latitude magnetosphere, measurements of electric fields in space, measurements of electric fields in the ionosphere and magnetosphere, theory of electric field measurements conducted in the magnetosphere with electric probes, satellite measurements of low-energy particles precipitated at high latitudes, energetic particle observations from IMP satellites, observations of particles in the tail of the magnetosphere by Vela satellites, suggestions for magnetospheric experiments, particle measurements on an ESRO satellite (Neutral I) in a highly eccentric polar orbit, and possible particle measurements in the high-latitude magnetosphere. (J.H.M.)

37279 (MIT-2098-361) SHOCK AND MAGNETOPAUSE BOUNDARY OBSERVATIONS WITH IMP-2. Binsack, Joseph H. (Massachusetts Inst. of Tech., Cambridge). Aug. 17, 1967. Contract AT(30-1)-2098. 35p. Dep. CFSTI.

The data from the M.I.T. plasma experiment on IMP-2 show that the boundaries of the magnetosheath are extremely pliable

and responsive to solar and geomagnetic activity. Further, even during relatively quiet periods, the boundaries appear to remain in motion although on a smaller scale. Both long term (hours) and short term (minutes) periodicities were observed. The actual shock boundary layer was observed, and rapidly varying fluxes in energy and direction are characteristic of the layer. (auth)

37280 (N-67-18040) COMPUTER ROUTINE FOR RELAY TRAPPED PROTON DISTRIBUTIONS. Fillius, R. Walker (California Univ., La Jolla, San Diego). Sept. 1, 1966. Contract NASr-116. 8p. (NASA-CR-81686). CFSTI.

The Fortran routine Relay I is described as an aid to scientists who desire easy computerized access to the trapped proton distribution measurements. The discussion covers the data reduction procedure, the coverage provided by the decks, the computation method, the call parameters, subroutines, timing, diagnostic printing, and tape assignments. A tabular summary is included on the Relay I orbit and instrumentation. (STAR)

37281 (N-67-19867) THE POLAR CAP ABSORPTION ON JULY 7-10, 1966. Hakura, Yukio (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Mar. 1967. 22p. (NASA-TM-X-55720). CFSTI.

Time history of a PCA on July 7-10, 1966, was analyzed using 16 riometers in the northern polar region and concurrent satellite observations of solar cosmic radiations. The PCA was attributed to a solar flare of importance 3 observed at 00:25 U.T. on July 7, that was accompanied by a major radio outburst of type IV. The first onset of PCA was noticed at 01:20 U.T. at Shepherd Bay, and the slight enhanced ionization of a few tenths of db covered the whole north pole region before 02:00 U.T. On the other hand, auroral zone stations observed the PCA after 02:00. The two-stepped onset of the PCA corresponds to the differential arrival of solar electrons and protons at the earth, detected by the satellite IMP-3. The PCA in the polar region marked a maximum of 2.5 db on 30 Mc at 13:00 on July 7, and then decayed gradually until it went down below 0.3 db after 23:45 on July 8. There was no discontinuous decrease in absorption in polar riometer as observed in the interplanetary proton intensity in association with an interplanetary shock wave, while the auroral zone stations observed a pronounced sudden commencement absorption. (auth) (STAR)

37282 (N-67-20378) AURORAL ZONE ELECTRON PRECIPITATION ACCOMPANYING A SUDDEN IMPULSE IN THE GEOMAGNETIC FIELD. Brown, R. R. (California Univ., Berkeley. Dept. of Physics). [1967]. 14p. (NASA-CR-82982). CFSTI.

Balloon observations of strong, transient magnetic disturbances were examined to determine what forms of electron precipitation occur, and the data are graphed. The bremsstrahlung found accompanying a sudden impulse of 955 γ in H indicates that the x-ray fluxes were soft, with e-folding energy $E_0 \approx 13$ keV beyond the low-energy portion strongly affected by atmospheric absorption and relatively unstructured in time. (STAR)

37283 (NASA-SP-54) SCIENTIFIC FINDINGS FROM EXPLORER VI. (National Aeronautics and Space Administration, Washington, D. C. Scientific and Technical Information Div.). 1965. 381p. GPO $2.25.

An analysis of data from the Explorer VI satellite that was launched August 7, 1959, is presented. Astronomy and celestial mechanics, energetic particles in a magnetic field, and ionospheric physics are discussed. (J.H.M.)

37284 (N-67-18957) IRREGULAR VARIATIONS OF EARTH'S ROTATION VELOCITY AND ACTION OF SOLAR CORPUSCULAR STREAMS ON THE EARTH'S MAGNETOSPHERE. Afanas'eva, V. I. Translated from Geomagn. Aeron., 6: 1094-5(1966). 8p. (NASA-CR-82436). CFSTI.

An attempt is made to explain the irregular variations of the Earth's rotation velocity by action of solar corpuscular streams on the Earth's magnetosphere, in particular on its tail, by discussing the position of the magnetosphere tail for various geomagnetic conditions, and then referring to the daily observation data collected between 1961 and 1963. A conventional parameter is computed on the basis of these data, and it is found that its behavior in all the cases considered was of the same order, independently from the objectives of the current note. The main argument in favor of the hypothesis brought forth in the accounting for the noncoincidence in the direction of the magnetic field of the stream and of the geomagnetic field in the tail, which is characterized by a certain asymmetry due to universal geomagnetic anomalies. (auth)

37285 CORRELATION OF DOSIMETRIC MEASUREMENTS WITH CHARGED-PARTICLE ENVIRONMENT OF THE INNER VAN ALLEN BELT. Thede, Allen L.; Radke, George E. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Trans. Amer. Nucl. Soc., 10: 375-6(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

37286 DEFLECTING ABSORPTION IN IONOSPHERIC E REGION. Serafimov, K. B. (Geophysical Inst., Sofia). Compt. Rend. Acad. Bulg. Sci., 19: 1015-18(1966). (In Russian).

The total absorption of radio waves in the ionosphere includes the deflecting absorption L_d and the nondeflecting absorption, L_n, that may be neglected. These types of absorption may be determined experimentally at dusk; they may also be obtained from a combined experimental and theoretical study, measuring two selected frequencies, using the author's previously published method. Variations in the value of L_d may be followed by studying the reflection of radio waves from the E region of the ionosphere; the data obtained allow one to calculate reflection from any other portion of the ionosphere. In the parabolic approximation of the expression derived for determining the height of the reflecting layer for the equivalent vertical frequency f_i, related to the reflected concentration of electrons N, the following correlation was established: $N = 1.24 \times 10^4 \times f_i^2$. In order to obtain data for the variation of L_d, data were collected during the summer and winter periods for intermediate latitudes, over the city of Sofia. The values obtained agreed with the literature data. (TTT)

37287 INNER-BELT PROTONS AND RADIAL DIFFUSION. Crifo, J. F. (Centre National de la Recherche Scientifique, Essonne, France); Mozer, F. S. Phys. Rev. Lett., 19: 456-9 (Aug. 21, 1967).

The measurement of protons with energies between 0.5 and 150 MeV made near L = 1.5, B = 0.18, on a sounding rocket launched from Algeria on September 30, 1965, to an altitude of 1750 km, is described. Analyses of the data indicate the following: (1) theories of radial diffusion driven by only the magnetic disturbances associated with sudden commencements and sudden impulses fail by many orders of magnitude to explain the observed flux of protons with energies near 500 keV at L = 1.5, B = 0.18; and (2) radial diffusion due to other possible classes of magnetic and electric field variations qualitatively explains the proton observations. (J.H.M.)

37288 PROTON EVENTS IN THE MAGNETOSPHERE ASSOCIATED WITH MAGNETIC BAYS. Konradi, Andrei (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 72: 3829-41(Aug. 1, 1967).

A series of 13 sudden increases in the proton flux was observed at L > 8 on the subsolar side of the magnetosphere during August, September, and October 1961. These increases are strongly correlated with the appearance of negative magnetic bays in the auroral zone. The increases exhibit proton intensities of J (>100 keV) $\lesssim 10^6$ p/cm^2 sec ster. The particle intensity rise time is of the order of 10 minutes. The protons have strongly peaked energy distributions, and the peak energy decreases with time during a period of about 1 hour from about 300 keV to 100 keV. The events are interpreted as protons drifting in the earth's magnetosphere after being injected into it on the night side. (auth)

37289 OBTAINING LOCAL VALUES OF PLASMA SCALE HEIGHT WITH THE ALOUETTE 1 TOPSIDE SOUNDER. Watt, Theodore M. (Autonetics, Anaheim, Calif.). J. Geophys. Res., 72: 3843-53(Aug. 1, 1967).

A consistent feature of Alouette 1 topside sounder ionogram analysis is that deduced values of plasma scale height exhibit very large scatter in the vicinity of the sounder, i.e., near 1000 km. Using a model ionosphere based on diffusive equilibrium theory, it is shown that virtual depth, wave frequency, and plasma scale height can be functionally related, and the sensitivities of deduced values of plasma scale height to scaled values of virtual depth and wave frequency are obtained numerically for several typical cases. Estimates are made of uncertainties in scaled values of virtual depth and wave frequency associated with the various parts of the sounding/recording/scaling process. It is shown how the error can be reduced, and an estimated minimum error figure is obtained for local values of plasma scale height. An important conclusion is that, using existing measurement and data reduction techniques, the accuracy of experimentally determined local values of plasma scale height is severely limited. (auth)

37290 VELA 3 MAGNETOGRAMS AT 18 R_E. STRUCTURE AND PULSATIONS IN THE MAGNETOSHEATH. Greenstadt, E. W.; Inouye, G. T.; Green, I. M.; Judge, D. L. (TRW Systems, Redondo Beach, Calif.). J. Geophys. Res., 72: 3855-76(Aug. 1, 1967).

Magnetograms obtained by the third launch Vela satellites in approximately circular orbits at average distances of 18 R_E are described, and examples of data from Vela 3A are presented. Special properties of the observed magnetosheath field are: (1) repeated apparent crossings and recrossings of the magnetosheath outer boundary, with individual crossings differing sharply in character from one another; (2) sudden enhancement of measured fluctuation amplitude in sections of the magnetosheath, including ap-

parent "double boundary" structure; and (3) appearance, in 20 to 50% of the magnetosheath data, of periodic and quasi-sinusoidal oscillations, including elliptically polarized waves, similar in period and appearance to pc 2, 3, and 4 surface micropulsations in the 6- to 60-second period range. Pulsation periods are concentrated around 12, 20, 30, and 60 seconds, and recorded sections of periodic character persist from several cycles at the longer periods to several hours at 6- to 13-second periods. Peak-to-peak amplitude of waves on the measurement plane range from 2 to 50 γ. (auth)

37291 PRELIMINARY RESULTS ON THE WAVELENGTH DEPENDENCE AND ASPECT SENSITIVITY OF RADAR AURORAL ECHOES BETWEEN 50 AND 3000 MHz. Leadabrand, Ray L.; Larson, Arvid G.; Hodges, James C. (Stanford Research Inst., Menlo Park, Calif.). J. Geophys. Res., 72: 3877-87(Aug. 1, 1967).

A six-frequency radar was operated at Homer, Alaska, to determine the wavelength dependence and aspect sensitivity of radar auroral echoes at 50, 139, 398, 850, 1210, and 3000 MHz. The lack of dependence of aspect sensitivity on frequency and the nature of the wavelength dependence indicates that the formulation for field-aligned scattering described by Booker is not adequate. It is believed that a more plausible model for the generation of field-aligned ionization is described by Farley. However, the nature of these results and the status of Farley's theory make quantitative comparisons beyond the scope of this work. (auth)

37292 A SEARCH FOR α PARTICLES TRAPPED IN THE GEOMAGNETIC FIELD. Fenton, K. B. (Univ. of Chicago). J. Geophys. Res., 72: 3889-94(Aug. 1, 1967).

Data from the University of Chicago charged-particle telescope on the satellite OGO 1 for the regions of the geomagnetic field in which protons of energy 26–85 MeV are trapped have been analyzed for the presence of α particles during a period near the minimum of solar activity (1964). The region of (B,L) space sampled is that for which $1.6 \leq L \leq 3.3$ and $0.01 \leq B \leq 0.25$. From an examination of samples of data in which a total of 15,000 trapped protons were observed, it is concluded that the upper limits for the α-particle–proton ratio are 1 in 1500 for the energy range 26–85 MeV/nucleon and less than 1 in 50 for the rigidity range 0.33–0.39 BV. It is inferred from the fact that the results indicate an almost pure proton source that the decay of energetic albedo neutrons must be the principal source of trapped protons at energies above 26 MeV. (auth)

37293 CHARACTERISTICS OF THE DYNAMIC SPECTRUM OF LONG-PERIOD GEOMAGNETIC PULSATIONS. Saito, Takao (Environmental Science Services Administration, Boulder, Colo. National Center for Atmospheric Research, Boulder, Colo.). J. Geophys. Res., 72: 3895-3904(Aug. 1, 1967).

Consideration is given to a broad-range dynamic spectrum display used for studying seven types of geomagnetic pulsations covering the frequency from 4 to 0.002 cps. Of particular interest is the pc 4,5 range of pulsations that displays several specific characteristics: (1) the spectra are very similar between the nearly conjugate stations Great Whale River, Canada, and Byrd, Antarctica; (2) the dynamic spectra show microstructure consisting of a series of discrete patches of about 10-min duration; (3) these patches are similar to those appearing in the dynamic spectrum of a damped pc 4,5 associated with ssc. A suggestion for possible excitation processes of the pc 4,5 is given. (auth)

37294 TWO SUBTYPES OF TYPE PI MICROPULSATIONS. Heacock, R. R. (Univ. of Alaska, College). J. Geophys. Res., 72: 3905-17(Aug. 1, 1967).

Two Pi subtypes were recognized in a study of three years of continuous magnetic tape and chart recordings made at College, Alaska. Impulsive broadband bursts occurring near local geomagnetic midnight are associated with impulsive ionospheric cosmic noise absorption events, and thus with impulsive bursts of charged particles, which seem to come down from the tail region of the magnetosphere. Another Pi subtype is nonimpulsive, narrower in frequency range, and seems to be generated mainly within the auroral electrojets. Simple events of the latter subtype were inaugurated by at least one impulsive Pi burst. "Elementary" Pi storms thus have two distinct components. (auth)

37295 PARTICLE TRAJECTORIES IN MODEL CURRENT SHEETS. 2. APPLICATIONS TO AURORAS USING A GEOMAGNETIC TAIL MODEL. Speiser, T. W. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 72: 3919-32(Aug. 1, 1967).

Individual particle trajectories are determined analytically and numerically in two possible configurations of electric and magnetic fields in the geomagnetic tail. The models are based on reconnection models incorporating a neutral point with associated neutral or current sheet and on the observed neutral sheet in the geomagnetic tail. Both models contain magnetic field lines oppositely directed on either side of a current sheet, with some field line connection through the sheet and with an electric field perpendicular to the magnetic field and parallel to the sheet. The models differ in the rate of variation of a magnetic field component perpendicular to the neutral sheet and hence in the rate of field line crossing of the neutral sheet. For the two models, particles are accelerated and turned toward the earth within the neutral sheet and are ejected from the neutral sheet with small pitch angles to a magnetic line of force, with energies of tens of kilovolts. For the first model a dipole and tail model, electrons are ejected at about 150 R_E and protons about 50 R_E back in the tail. For the second model, an extended tail model, electrons are ejected at about 500 R_E, and protons at about 400 R_E. Proton auroras would be expected about $\frac{1}{2}°$ lower latitude than electron auroras, and isotropic fluxes should be measurable out to distances of the order of 2.5 R_E from the earth. Extremely thin sheets of incoming particles are produced about 1 km for electrons between 1 and 10 keV. These results are obtained from an approximate, nonadiabatic theory and are verified by machine computations. To map the thin output sheets onto the earth, a three-dimensional dipole and tail model is used for the numerical computations of many proton trajectories. Thin output sheets of accelerated particles are found using Liouville's theorem. These thin sheets or spatially intense regions are near the auroral zones when mapped onto the earth; they move to lower latitudes on the earth with an increase in the strength of the tail field, and their thickness is roughly proportional to the thermal velocity of the particles incident on the tail. The geomagnetic tail may sometimes be quite long without field-line merging and may sometimes be shorter with merging. These models may therefore be useful in the description of auroral acceleration whenever the merging process is going on. The models may be applicable to other situations where neutral points or sheets may exist, such as the day-side magnetospheric current sheet, the interplanetary field, solar flares, etc. If H_e auroral emission occurs as as suggested by Eather, these results imply that alphas should be found equatorward of precipitating protons with about twice the proton energy. (auth)

37296 THE PRODUCTION OF NO_3^- BY ELECTRON TRANSFER FROM O^-, O_2^-, O_3^-, AND OH^- TO NO_2. Rutherford, J. A.; Turner, B. R. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Geophys. Res., 72: 3795-3800(Aug. 1, 1967).

Cross sections for several charge-transfer reactions have been measured in the energy range 2 to 400 eV using a crossed ion and neutral beam configuration and employing mass analysis of the product ions. The charge-transfer cross sections of O_2 in collisions with O^- and O_3^- were determined and the results compared with those obtained by using an electron-filter collision chamber. Reasons are given for the discrepancies that were noted. The collisions between NO_2 and the negative ions O^-, O_2^-, O_3^-, and OH^- were studied, and all of these charge-transfer cross sections were found to be large and to increase with decreasing ion energy. The cross sections for the reactions leading to NO_3^- formation are extrapolated to interaction energies in the thermal energy range. (auth)

37297 EXTRATERRESTRIAL RING CURRENT DURING GEOMAGNETIC STORMS. Frank, L. A. (Univ. of Iowa, Iowa City). J. Geophys. Res., 72: 3753-67(Aug. 1, 1967).

Measurements of the differential energy spectrums of protons and electrons, separately, over the energy range extending from ~200 eV to 50 keV with a sensitive array of electrostatic analyzers borne on the earth-satellite OGO 3 reveal large temporal variations in intensities of these low-energy charged particles at low and moderate latitudes in the outer radiation zone during two moderate geomagnetic storms in late June and early July 1966. At L = 3.5 on July 9, for example, the intensities of protons ($31 \leq E \leq 49$ keV) increased by factors $\gtrsim 30$ over the pre-storm intensities. The peak proton (200 eV $\leq E \leq$ 50 keV) energy densities at the magnetic equator for June 23 (relative magnetic quiescence), June 25 ($D_{ST}(H) \simeq -30\ \gamma$), and July 9 ($D_{ST}(H) \simeq -50\ \gamma$) were 9×10^{-8} erg(cm)$^{-3}$ at L = 6.8, 2×10^{-7} erg(cm)$^{-3}$ at L = 4.5, and 5×10^{-7} erg(cm)$^{-3}$ at L = 3.3, respectively. This energy density is predominantly shared by protons in the energy range ~3–50 keV. The total energy of these low-energy protons and electrons within the earth's magnetosphere is sufficient to account for the depression of the geomagnetic field ($D_{ST}(H)$) observed at the earth's surface over low and moderate latitudes; hence these charged particles may be identified as the major contributors to the storm-time extraterrestrial ring current. Electrons (200 eV $\leq E \leq$ 50 keV) are found to provide approximately 25% of this storm-time ring current. The apparent mean lifetimes of low-energy protons in the outer radiation zone are in agreement with calculated lifetimes assuming charge-exchange collisions with the ambient neutral and charged constituents of the terrestrial exosphere as the predominant loss mechanism. (auth)

37298 PROBABLE OBSERVATIONS OF THE GEOMAGNETIC TAIL AT 10^3 EARTH RADII BY PIONEER 7. Ness, Norman F.; Scearce, Cleil S.; Cantarano, Sergio C. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 72: 3769-76(Aug. 1, 1967).

Pioneer 7 passed through the downstream region of solar wind interaction with the geomagnetic field at 900–1050 R_E during September 26 to October 3, 1966. Detailed measurements of the magnetic field suggest that certain of the magnetic lines of force connect to the earth through the geomagnetic tail. A coherent, well-ordered tail with embedded neutral sheet does not appear to have been observed. This suggests that the geometry of the tail changes to a complex set of intermingled filamentary flux tubes at several hundred R_E. (auth)

37299 DELAYED GENERATION OF AN ELECTROMAGNETIC PULSE IN THE TOPSIDE IONOSPHERE. Muldrew, D. B. (Defence Research Telecommunications Establishment, Ottawa). J. Geophys. Res., 72: 3777-94(Aug. 1, 1967).

High-latitude, topside, spread-F ionograms often show a trace protruding from the spread F of the extraordinary wave trace at frequencies slightly greater than twice the electron cyclotron frequency at the height of the satellite. The characteristics of this trace, called the remote-resonance trace, can be explained by the following model: a transmitted pulse of angular frequency ω propagates downward, along a magnetic field-aligned wave guide, through the height at which ω is equal to twice the local electron cyclotron frequency $2\omega_H$. A gradient in the electric field of the transmitted wave results from the variations in electron concentration across the guide. Owing to this gradient, electrons gyrating in the magnetic field with certain phases can gain energy from the wave, whereas electrons with other phases can lose energy to the wave. The electrons that gain the largest amount of energy from the wave have, immediately following the passage of the downward-propagating wave, a particular phase distribution with height. This distribution changes with time in such a way that at some time τ_0, after the passage of the transmitted pulse, the distribution corresponds to that which would be produced by an upward-propagating wave. Owing to variations in the electric field of the downward-propagating wave (or in the electron concentration or temperature) electric currents of frequency $2\omega_H$ can flow in the medium and, at the time τ_0, an upward-propagating pulse can be generated that is responsible for producing the remote-resonance trace on ionograms. This model successfully accounts for the time delay of the remote-resonance traces observed on Alouette ionograms. Energy considerations indicate that variations in the electric field of the downward-propagating wave of several percent within a distance of one electron cyclotron radius are required to explain the strength of the remote-resonance echoes. Consideration is given to the parameters required for the observation of remote-resonance echoes from laboratory plasmas. (auth)

37300 LABORATORY SIMULATION OF A SATELLITE-MOUNTED PLASMA DIAGNOSTIC EXPERIMENT. Kasha, M. A.; Johnston, T. W. (RCA Victor Research Labs., Montreal). J. Geophys. Res., 72: 4028-30(Aug. 1, 1967).

The laboratory simulation of a direct-measurement plasma diagnostics experiment, of the type used in the Explorer 8 space vehicle, including the electromotive effect of the satellite's motion through the earth's magnetic field, is reported. The device tested was a system for total plasma current measurement. (J.H.M.)

37301 HIGHLY ASYMMETRIC MHD RESONANCES: THE GUIDED POLOIDAL MODE. Radoski, Henry R. (Boston Coll., Weston, Mass.). J. Geophys. Res., 72: 4026-7(Aug. 1, 1967).

The physical meaning of the highly asymmetric equation for Alfvén wave propagation in a dipole field, expressed in dipole coordinates, is shown. It is also shown that the equation can always be solved. (J.H.M.)

37302 NOTE ON THE MAGNETIC-MOMENT ADIABATIC INVARIANT FOR PARTICLE MOTION IN A DIPOLE MAGNETIC FIELD. Heckman, Harry H. (Univ. of California, Berkeley). J. Geophys. Res., 72: 4016-19(Aug. 1, 1967). (UCRL-17308).

The magnetic moment adiabatic-invariant series is evaluated through second order in the expansion parameter for the case of a particle at the equatorial plane of a dipole magnetic field. (J.H.M.)

37303 ADIABATIC BETATRON ACCELERATION BY A GEOMAGNETIC STORM. Fillius, R. Walker; McIlwain, Carl E. (Univ. of California, San Diego, La Jolla). J. Geophys. Res., 72: 4011-15(Aug. 1, 1967).

The concept that reversible betatron acceleration in the earth's field can be pictured as the result of two betatrons acting simultaneously is shown. The configuration consists of a gyrobetatron in which the curl of E acts around the circle of gyration and a drift betatron in which the curl of E acts around the drift circle. (J.H.M.)

37304 GEOMAGNETIC EULER POTENTIALS. Stern, David (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 72: 3995-4005(Aug. 1, 1967).

It is well known that magnetic fields may be represented by the cross product of the gradients of two scalars α and β ("Euler potentials") and that such a representation has considerable use in the description of field lines and guiding center motion. Owing to practical difficulties, however, such potentials are known only for relatively simple configurations, including the field of a magnetic dipole. A perturbation scheme is developed by which, given the spherical harmonic expansion of the geomagnetic scalar potential and treating it as representing a perturbed dipole field, Euler potentials can be derived to any desired order of accuracy. Its first-order solutions involve trigonometric integrals $V_n^m(\vartheta)$ and $t_n^m(\vartheta)$ previously defined by Pennington, which may be expressed in closed form; tables of coefficients enabling one to obtain these integrals up to n = 6 are included. The results are tested for the internally generated geomagnetic field by mapping lines of constant α and β on the earth's surface: conjugate points (which have the same α and β) are obtained with typical accuracy of 1 to 2°. The method is also applied to a magnetospheric model in which external sources are added to represent the effect of the solar wind; although this model clearly breaks down at large distances, it gives fairly good results within about 10 R_E, including a "magnetopause" on which two neutral points are located. (auth)

37305 POSSIBLE EXPLANATION OF THE SUDDEN COMMENCEMENT AND INITIAL PHASE OF A MAGNETIC STORM IN TERMS OF INDUCED IONOSPHERIC CURRENTS. Closs, R. L. (Univ. of Hong Kong). J. Geophys. Res., 72: 3987-93 (Aug. 1, 1967).

It is assumed that during a magnetic storm the earth is situated in a magnetic field whose intensity increases exponentially up to the maximum of the main phase of the storm. The occurrence of a sudden commencement and an initial phase is then explained entirely in terms of currents induced in the ionosphere. In a first model the ionosphere is treated as a spherical layer of uniform conductivity and finite thickness. In a second model only the currents induced in the high-conductivity bands at the equator and the auroral zone are considered. The variations in the earth's magnetic field during a magnetic storm calculated by using these models agrees well with the average variations observed at stations with low and middle magnetic latitudes. (auth)

37306 CALCULATIONS OF THE PHOTOELECTRON EXCITATION OF THE DAYGLOW. Green, A. E. S. (Univ. of Florida, Gainesville); Barth, C. A. J. Geophys. Res., 72: 3975-86 (Aug. 1, 1967).

The rate of excitation of the dayglow by photoelectrons is determined by electron energy loss calculations. The loss function is calculated for a 45% atomic oxygen, 45% molecular nitrogen, and 10% molecular oxygen atmospheric mixture. Energy transfer functions are calculated for exciting these atmospheric species by photoelectrons produced in the ionization of the atmosphere by extreme ultraviolet solar radiation. The calculations are applied to a 1963 model atmosphere to give the height dependence of volume emission rate and the column emission rate for the following dayglow features: atomic oxygen 1304, 1356, 7773, and 8447 A lines; molecular nitrogen first negative, Meinel, second positive, first positive, Vegard–Kaplan, Lyman–Birge–Hopfield, and Birge–Hopfield bands; molecular oxygen first negative and second negative bands. (auth)

37307 CALCULATIONS OF AURORAL INTENSITIES FROM ELECTRON IMPACT. Stolarski, R. S.; Green, A. E. S. (Univ. of Florida, Gainesville). J. Geophys. Res., 72: 3967-74(Aug. 1, 1967).

The energy deposited in the excited states of N_2, O_2, and O from the slowdown of electrons in the 0.1–30-keV range is calculated from the extensive sets of electron impact cross sections of Green et al. These results are then used to calculate the radiation from many of the important auroral transitions. Comparison with experiment is then obtained by normalizing to the first negative bands of N_2^+. Also, the average eV/ion pair in the slowdown process was calculated with consideration given to the details of the low-energy secondaries and tertiaries. (auth)

37308 OBLIQUE ELECTROMAGNETIC RADIATION INCIDENT ON A SEMI-INFINITE WARM GENERAL MAGNETOPLASMA. Unz, H. (RAND Corp., Santa Monica, Calif.). Nuovo Cim. (10), 50B: 207-23(Aug. 11, 1967).

The refractive index general sixth-order algebraic equation is derived for arbitrarily directed oblique waves in compressible general magnetoplasma with arbitrarily directed magnetostatic

field. The problem of a plane electromagnetic wave with arbitrary polarization incident obliquely on a semi-infinite compressible general magnetoplasma is solved and the corresponding reflection and transmission coefficients are found. (auth)

37309 IONOSPHERIC EFFECTS OF NUCLEAR EXPLOSIONS. I. Kotadia, K. M. (Gujarat Univ., Ahmedabad, India). Ann. Geophys., 23: 1-11(Jan.-Feb.-Mar. 1967).

The effects of nuclear explosions carried out in USSR during the last 4 months of 1962 were studied in relation to barometric and ionospheric change. The initial effect of the disturbance caused by the nuclear explosion was a sharp increase in barometer pressure at ground level, and a decrease in electron density of the F2 layer, the latter particularly for yields greater than 10 Mt. The average velocity of the disturbance in the lower atmosphere was about 303 m/sec at a distance of about 3000 km from the explosion center, whereas that of the disturbance in the F2 layer of the ionosphere was about 610 m/sec. The period of oscillation in barometric pressure was not more than 6 min, decreasing with time, while that of oscillations in electron density was ~100 to 140 min, higher values being for weaker explosions. The period and amplitude of the oscillatory changes in the lower and upper atmosphere depended on several factors, such as time, season, latitude, and magnitude of the explosion. While the barometric fluctuations due to the travelling disturbance lasted for about an hour, those of electron density in the F2 layer were observed throughout daytime hours. The latter invariably died out after 1800 hr, regardless of the time and strength of the explosion. The disturbance travelling outwards from the explosion propagated from the lower to higher regions of the ionosphere. Barographic, ionospheric, and geomagnetic observations provided a check as to the altitude, distance, and strength of the detonations. (BBB)

37310 EVIDENCE FOR RADIO PULSES FROM EXTENSIVE AIR SHOWERS AT LARGE ZENITH ANGLES. Charman, W. N.; Fruin, J. H.; Jelley, J. V.; Porter, R. A.; Smith, F. G. Zh. Eksp. Teor. Fiz., 53: 88-97(July 1967). (In Russian).

An experiment to detect radio pulses in coincidence with pulses of atmospheric Cherenkov light from cosmic-ray extensive air showers at large zenith angles (~75°) is described. A frequency $\nu = 44$ MHz and band-width $\delta\nu = 3$ MHz were employed, the field of view being 0.06 sr. The experimental evidence suggests that radio pulses caused by showers were observed at a rate 0.17 hr^{-1}, this being much higher than that found in previous observations near the zenith. (auth)

37311 A PHOTOMETRIC STUDY OF THE (9-4) AND (7-3) OH EMISSION BANDS IN THE NIGHT AIRGLOW AT POONA. Chiplonkar, M. W.; Tillu, A. D. (Univ. of Poona, India). Indian J. Pure Appl. Phys., 5: 87-92(Mar. 1967).

The studies were carried out using a specially designed photoelectric photometer incorporating a DuMont 6911 photomultiplier sensitive to the near infrared and two narrow band interference filters with maximum transmissions at 7750 and 8860 Å regions corresponding to the two bands studied. Observations were made at a field station at Narayangaon (655 m above m.s.l.), 75 km northeast of Poona, on 40 moonless clear nights during the period Jan.–Mar. 1964. Absolute intensities of the bands were determined, using the calibration constants and correction factors for molecular scattering, extinction, and specific absorption by water vapor. The mean nocturnal intensity variation curves show that the intensities are maximum at about one hour after the end of twilight and thereafter decrease rapidly up to dawn, the ratio of maximum to minimum intensity being 10:1. Such a high ratio has not been reported earlier and seems significant. The mean zenith intensities for the two bands are found to be 1.14 and 2.88 k Rayleighs which compare well with values of 0.71 and 2.80 Rayleighs predicted theoretically. These intensities were used for estimating the contaminations by the OH bands of the simultaneously measured intensities at this station of the visible radiations at 5577, 5893 and 6300 Å. This procedure for the estimation of contaminations is justified by the two conclusions, viz., (i) both the emissions are found to originate at almost the same height around 110 km. and (ii) the intensities of the two bands are highly correlated throughout the night, arrived at as a result of the analyses of the observations. (auth)

37312 MAGNETOSPHERIC IONIZATION DENSITY PROFILES AND WHISTLER PROPAGATION. Gopal Rao, M. S. V. (Coll. of Engineering and Technology, New Delhi). Indian J. Pure Appl. Phys., 5: 93-5(Mar. 1967).

The guidance of audiofrequency electromagnetic waves along the earth's magnetic field in the absence of field-aligned irregularities of ionization density was investigated. Imposing the conditions for guidance with appropriate ionization density gradient transverse to the magnetic field, certain models of ionization distributions in the magnetosphere were calculated for guidance. Apart from the assumed inverse proportionality of ionization density to some power of the geocentric distance, it is found that the density should also be a function of latitude, the two being interdependent. Cases of both increase and decrease of ionization density from the geomagnetic equator to the poles have been encountered. For the most likely radial decrease, the ionization density must be rather sharply concentrated near the equator to overcome the higher curvature and greater geocentric distance of the field lines near the equator. (auth)

37313 VLF AND ELF WAVES IN THE NEAR-EARTH PLASMA. Al'pert, Ya. L. Space Sci. Rev., 6: 781-840(May 1967).

Experimental data and numerical calculations are presented in a study of low-frequency oscillations and waves in the near-earth plasma. Basic parameters of the outer ionosphere for different distances from the earth's surface are given. Consideration is given to the refraction index of waves of various types and their Cherenkov and cyclotron damping coefficient on electrons and ions. Information is included on transverse and longitudinal waves, vlf and elf signals of discrete type (wave packets observed in the form of separate, relatively short signals), energy fluxes of vlf and elf waves, and conditions for wave excitation. (J.H.M.)

37314 RADIOPHYSICS OF JUPITER. Warwick, James W. (Univ. of Colorado, Boulder). Space Sci. Rev., 6: 841-91(May 1967).

The observational and theoretical developments regarding the nonthermal radio emission from Jupiter, since 1963, are summarized. The emphasis is on new data, and their phenomenological interpretation. A more basic, deductive analysis of Jovian radiophysics does not appear possible with the present state of knowledge of the planet. The "cutoff" date of the review is roughly October, 1966, although some more recent material available in preprint form has also been included. (W.D.M.)

37315 LONGITUDINAL PROPAGATION IN A LAYERED MAGNETO-IONIC MEDIUM (EPSTEIN PROFILE). Blok, H. (Technische Hogeschool, Delft, Netherlands). Appl. Sci. Res. (The Hague), 17: 331-9(1967).

The longitudinal propagation and reflection of a plane electromagnetic wave in a horizontally stratified magneto-ionic medium is considered. In this case Maxwell's equations reduce to two uncoupled ordinary second-order differential equations, describing the propagation of two elliptically polarized plane waves. The electron density of the medium is assumed to vary with the vertical Cartesian coordinate z according to the Epstein law. Rigorous solutions of the relevant differential equations can be obtained either in the form of hypergeometric functions or in the form of an integral representation. The reflection coefficients of both waves are then expressed in terms of gamma functions. The following quantities are considered in detail in their dependence on the parameters involved: the modulus of the reflection coefficient, the phase delay time, and the group delay time. Some numerical results are given. (auth)

37316 ATMOSPHERIC PRESSURE WAVES FROM NUCLEAR EXPLOSIONS. McCrory, R. A. (New Mexico Inst. of Mining and Tech., Socorro). J. Atmos. Sci., 24: 443-7(July 1967).

Pressure waves recorded at Socorro from atmospheric nuclear tests on September 27 and October 30, 1962, are shown and discussed. Dispersion curves from the analysis method of Ewing and Press are presented. Also included are Fourier analyses of the September 27 record and of a theoretical microbarogram calculated from a 114-km model atmosphere. A comparison of the two methods of dispersion analysis demonstrates that the Fourier analysis method of Pfeffer and Zarichny characterizes the dispersion more clearly and more completely than does the method of Ewing and Press. (J.H.M.)

37317 CHARGED PARTICLE MOTION IN ONE-DIMENSIONAL MODEL OF THE TRANSITIONAL LAYER IN MAGNETOSPHERE. Samokhin, M. V. Kosm. Issled., 5: 157-9(Jan.-Feb. 1967). (In Russian).

The equations describing the motion of charged particles in the one-dimensional model of the transitional layer of the magnetosphere are derived. (J.S.R.)

37318 AURORA POLARIS. Krasovskii, V. I. Kosm. Issled., 5: 71-81(Jan.-Feb. 1967). (In Russian).

It appears that different exciting agents and types of aurora polaris correlate with identical geomagnetic disturbances. One type is connected with a very strong initial heating of the upper atmosphere by magnetohydrodynamic waves. It is accompanied in the basic red irradiation by emission of O_2. Another type is connected with the intrusion in the atmosphere of low-energy protons and electrons. The most intense radiation arises from electrons, penetrating at heights of about 100 km. Questions connected

with the susceptibility and nonsusceptibility of the earth's magnetosphere to the influence of solar winds are also considered. (tr-auth)

37319 PRECISION OF DETERMINATION OF ELECTRON CONCENTRATION IN IONOSPHERE BY MEANS OF COHERENT FREQUENCIES. Misyura, V. A.; Solodovnikov, G. K.; Migunov, V. M. Kosm. Issled., 5: 82-96(Jan.-Feb. 1967). (In Russian).

The methods and results of a theoretical and experimental study of errors in measurements by satellite of local electron concentration N_B in the ionosphere and, generally, dependence of the coefficient of refraction n of the ionosphere on three coordinates and time are given. The study was made for the orbital paths of satellites of the Kosmos and Elektron series at altitudes up to ~3000 km by using a coherent frequency method. The effects of horizontal gradients were included in the ionospheric model used for theoretical calculations. Experimental results were obtained by using the measured differences Φ of the Doppler frequency shifts in the coherent radio waves for calculation in a "chain" method originally proposed by Ya. L. Al'pert. A good correspondence, typical (~20%) for error values δN_B in ionospheric measurements of N_B was obtained between the experimental and theoretical values. Satisfactory agreement was obtained between values of N_B obtained through simultaneous measurements of Φ at widely separated points (Moscow, Khar'kov, Sverdlovsk, Tbilisi). The nonstationary nature of the ionosphere was found to have immaterial effects on the measurements of N_B. (ATD)

37320 INFLUENCE OF CORPUSCULAR FLUX AND ELECTRON PHOTOTRAPPING REACTIONS ON THE D-LAYER FORMATION IN THE IONOSPHERE. Bragin, Yu. A.; Kostko, O. K.; Repnev, A. I.; Shvidkovskii, E. G. Kosm. Issled., 5: 97-100(Jan.-Feb. 1967). (In Russian).

From direct measurements indicating the comparatively high and time-constant concentration of charged particles between 60 and 80 km, the concentration of electrons in the D region of the ionosphere was calculated for day and night. The increase of the electron concentration in the day in lower ionosphere can be explained by phototrapping reactions. It is proposed that one of the principal ionizing agents supporting during the day the high degree of ionization at heights of 60 to 80 km are particles entering from the earth's radiation belt. (tr-auth)

37321 INVESTIGATION OF THE COMPOSITION OF THE ATMOSPHERE AT 100 TO 60 km ELEVATIONS. Mirtov, B. A.; Starkova, A. G.; Shirshov, R. P. Kosm. Issled., 5: 101-9(Jan.-Feb. 1967). (In Russian).

The use of radiofrequency mass spectrometers for investigation of the composition of the persistent gas particles of the atmosphere below 100 km was examined. The construction of a batch input system not needing additional pumping out and some factual data on its operation under laboratory conditions are reported. At constant stability of the system its capacity can guarantee the investigation of atmospheric layers at heights of 120 to 65 km, and the analysis can be carried out at every two to three km of altitude. The precision of the analysis is 20 to 25%. (tr-auth)

37322 EXPERIMENTAL STUDIES OF PLASMA IN NEAR LUNAR SPACE BY MEANS OF CHARGED PARTICLE TRAPS INSTALLED IN THE FIRST MOON SATELLITE. Gringauz, K. I.; Bezrukikh, V. V.; Khokhlov, M. Z.; Zastenker, G. N.; Remizov, A. P.; Musatov, L. S. Kosm. Issled. Akad. Nauk SSSR, 4: 851-70(Nov.-Dec. 1966). (In Russian).

Data are presented on plasma in the "tail" of the Earth's magnetosphere at large distances from the Earth and on plasma in near-lunar space. The device, with four charged-particle traps, installed in satellite Luna 10 for collecting the data is described. The changes in the trap collector currents during Luna 10 crossing the tail of the Earth's magnetosphere were analyzed. The data are used for evaluating the upper boundary of possible concentration of thermal charged particle in the lunar ionosphere. (tr-auth)

37323 DEPENDENCE OF LAYER E2 ON HEIGHT OF SUN AND GEOGRAPHIC LATITUDE. Kassimova, A.; Serafimov, K.; Petkova, L. (Inst. of Geophysics, Kiev. Inst of Geophysics, Sofia). Compt. Rend. Acad. Bulg. Sci., 20: 425-8(1967).

A wider network of stations was used to check the correctness of a previously found expression for the dependence between the critical frequency f_0E2 and the zenith angle of the sun χ: $F_0E2 \sim \cos n\chi$. Daily changes in the value of the exponent n are noted and explanations are proposed. Plots of the averaged seasonal changes of n show that the exponent falls during the transition from winter to summer. Estimation of the dependence of n on geographical latitude indicates that n values from the equator to the 40° parallel are approximately equal, although a slight minimum is observed between 20 and 30°. A study of the latitudinal distribution of the magnitude of f_0E2 led to the conclusion that, with equal zenith angles of the sun, the lowest f_0E2 values fall on the equator and that these values gradually increase up to latitude 40°. (A.G.W.)

37324 SEASONAL CHANGES IN APPEARANCE OF E2 LAYER. Serafimov, K.; Petkova, L. (Geological Inst., Sofia). Compt. Rend. Acad. Bulg. Sci., 20: 421-4(1967).

Observations of the appearance of the E2 layer over the period 1960 through 1965 are analyzed. A previously established maximum in winter and a minimum in summer were confirmed. A second smaller peak in March was also found. This second peak can be explained by the major changes in the total circulation of the high atmosphere, which set in during the transition from winter to spring. In general the results confirm a previously developed mechanism that explains the daily and seasonal changes through the screening action of the normal E region. (A.G.W.)

37325 INVESTIGATION OF THE X RADIATION FROM THE MOON RECORDED BY LUNA-10 SATELLITE. Mandel'shtam, S. L.; Tindo, I. P.; Karev, V. I. Kosm. Issled. Akad. Nauk SSSR, 4: 827-37(Nov.-Dec. 1966). (In Russian).

Characteristic curves of fluorescence intensity of silicon, aluminum and magnesium in the surface layer of moon rocks, excited by solar x radiation were investigated. Descriptions are given of the device installed on Luna-10 satellite for recording the lunar x radiation. Results of measurements of the background effects of cosmic rays around the moon are given, and 40 keV electrons of the Earth's magnetospheric "tail" were found. (tr-auth)

37326 RESULTS FROM MULTIFREQUENCY OBSERVATIONS OF ELECTRON DENSITY WITH THE S66 SATELLITE. Schmelovsky, K. H.; Felske, D. (Observatorium fuer Ionosphaerenforschung, Kuehlungsborn, Ger.). Z. Geophys., 33: 155-62(1967).

The mean variations in the ionosphere of total electron content with latitude and local time between 64 and 46°N for winter 1965/66 as obtained from dispersive Doppler investigations are presented. Apart from minor deviations from the result of theoretical calculations, no unexpected features were observed. For disturbed times in high latitudes, additional ionization, probably caused by the radiation belt was observed. In one investigation the evaluation of Faraday fading on 20/40/41 MHz and of dispersive Doppler on 20/40 MHz was combined. By this method more reliable values of total electron content and additional information concerning the electron density distribution were obtained. By fitting theoretical models to these parameters and the results of simultaneous probe measurements, a mean daytime electron density model was obtained. The plasma temperature is about 1100°K and the molecular weight at 900 km about 8.5 amu. (BBB)

37327 ON THE POST-CULMINATION MAXIMUM IN LAYER F2. Serafimov, K.; Gorinov, N. (Inst. of Geophysics, Academy of Sciences, Bulgaria). Compt. Rend. Acad. Bulg. Sci., 20: 301-4(1967).

Changes of critical frequencies (maximum electron concentration) in the ionospheric F2 layer after the Sun's culmination are discussed. Information is included on afternoon and evening maxima, effects of solar activity on the maxima, latitudinal behavior, and seasonal changes. (J.H.M.)

37328 EFFECT OF SOLAR FLARES ON LOW IONOSPHERE. Velinov, P.; Nestorov, G. (Inst. of Geophysics, Academy of Sciences, Bulgaria). Compt. Rend. Acad. Bulg. Sci., 20: 293-6 (1967).

A number of studies have appeared on the ionospheric effects of solar flares accompanied by x radiation. An attempt is made to bring the theoretical solution of the problem as close as possible to the actual conditions prevailing in the ionosphere during the flare. For this purpose the fact that the form of x-radiation pulse correlates very well with that of the Sun's radiation in the cm range is considered. (W.D.M.)

37329 ANALYTICAL METHOD FOR DETERMINATION OF ELECTRON DENSITY IN THE MAGNETOSPHERE FROM WHISTLER DATA. Schreiber, H. (Univ., Goettingen, Ger.). Z. Geophys., 33: 110-30(Apr. 1967). (In German).

On the basis of longitudinal propagation of whistlers, the travel-time integral was investigated. The geomagnetic field was approximated by a dipole field. Assuming simple power functions for the electron-density distribution, the travel-time integral was developed into convergent power series. From this, the travel time of whistlers could be calculated analytically as a function of frequency and of the point at which the field line belonging to the whistler path intersects the earth's surface. Furthermore, the calculation gave a unique relation between the colatitude of the intersecting point and the whistler noise frequency, by which the whistler ray path could be determined. The influence of the lower ionosphere on the travel time and noise frequency could be taken into account. Some noise whistlers recorded at the Stanford and Seattle stations during the summer of 1961 were inves-

tigated. They gave an average nighttime electron density distribution of $N = 3.4 \cdot 10^{29} r^{-4}$ (N = electrons per cm^3, r = geocentric distance in cm) between 2 and 5 earth's radii geocentric distance. A comparison of this result with other electron density profiles published so far showed differences up to a factor of 2. These differences were mainly due to actual variations in the magnetospheric electron density. (BBB)

37330 RECENT IONOSPHERIC SOUNDING. Nishikori, Kiyoshi (Ministry of Posts and Telecommunications, Tokyo). Electron. Commun. Jap. (Engl. Transl.), 49: 111-23(Jan. 1966).

Advances in ionospheric research are reviewed. Because of recent developments of radio-wave techniques and space vehicles, new methods of ionospheric sounding have been introduced. In addition to the conventional ground-based method of transmitting radio waves from the earth, it is now possible to use rockets and artificial satellites for directly measuring physical properties and phenomena in the ionosphere. Furthermore, the development of the topside sounder method has made it possible to detect the distribution of electron density in the upper side of the ionosphere, not previously reached by the ground-based sounders. The incoherent back-scatter system employing a high-power pulse radar operating on more than a megawatt in the vhf and uhf bands and using a high-gain antenna in large facilities is also considered. Also discussed are other methods of obtaining profiles of electron density in the lower side of the ionosphere; for example, the Luxemburg-effect method using high-power transmission waves which artificially heat the ionosphere and produce variation in attenuation of the radio waves along their path in the ionosphere; the Riometer method, which can obtain profiles from the attenuation characteristics of space noise; and the variable-frequency ionosonde methods which cover the low-frequency range of 50 kc to 1 Mc. Recently new attempts to measure the physical quantities in the lower side of the ionosphere by a radar with a high-output laser have been made. Future developments of new measurement systems are also speculated on. (BBB)

37331 ON THE SPACE DISTRIBUTION OF THE IONOSPHERIC SPORADIC E LAYER. Vinogradov, Yu. I. Izv. Krym. Astrofiz. Observ., 37: 121-7(1967). (In Russian).

The space distribution of the ionospheric sporadic E layer (E_s) is considered on the basis of observational data obtained at 10 ionospheric stations in the USSR. Simultaneous bursts fE_s at stations located at very remote distances are detected. It is found that the appearance of simultaneous bursts fE_s at the stations compared is not accidental. The existence of a dependence between the critical frequencies of the sporadic E layer and latitude is shown. (auth)

37332 MAGNETOSPHERE AND AURORAS. O'Brien, Brian J. (Rice Univ., Houston, Tex.). Astronaut. Aeronaut., 5: No. 7, 16-17; 20; 22-4; 26(July 1967).

A review is presented of previous magnetospheric and auroral research. Various techniques and the use of experimental platforms (ground-based, balloon-borne, rocket-borne, and satellite-borne) for probing the magnetosphere are discussed. Included is a configuration of the magnetosphere showing the solar wind, shock front, magnetosheath, magnetopause, auroras, radiation belts, and plasma sheet. Electromagnetic waves, wave-particle interactions, magnetospheric knee, and trapped particles are considered. (J.H.M.)

37333 POLOIDAL AXISYMMETRIC RESONANCES: A SEPARABLE CASE. Radoski, Henry R. (Boston Coll., Weston, Mass.). J. Geomagnet. Geoelec., 19: 1-5(1967).

The longitude independent wave equation for the poloidal or isotropic magnetohydrodynamic resonances of a plasma magnetized by a dipole field is solved under the assumption of an Alfvén velocity increasing linearly with radial distance and retaining the latitude dependence of the magnetic field. Such a radial dependence is the only case in which the equation is separable in spherical coordinates and the solution possesses several advantages: the radial functions are particularly simple, the eigenfrequencies are derivable from an algebraic equation, and the contribution of the magnetic field's polar angle dependence can be clearly observed. (auth)

37334 PRELIMINARY RESULTS ON THE EQUATORIAL ELECTROJET IN INDIA. Onwumechilli, A.; Ogbuehi, P. O. (Univ. of Ibadan, Nigeria). J. Geomagnet. Geoelec., 19: 15-22 (1967).

A method is described for obtaining the parameters of the equatorial electrojet on individual days using a new model of the electrojet and data from a few observatories close to the same longitude. Preliminary results of applying this to the equatorial electrojet in India are given. The electrojet seems to be wider in Peru and narrower in Nigeria than in India. The intensity of the electrojet is negatively correlated with the intensity of the world-wide Sq current. The fluctuations in electrojet parameters in September 1958 are given. (auth)

37335 A STUDY OF SCHMIDT'S PHENOMENON IN THE S-CURRENT SYSTEM AND IN THE 10.7-cm RADIO NOISE FLUX. Gupta, Jagdish C. (Univ. of California, Los Angeles). J. Geomagnet. Geoelec., 19: 23-6(1967).

It is shown that the time of ascent and descent of the S-current intensity during an "intense" sunspot cycle is nearly 4 and 7 years, respectively. On the other hand, in a "weak" sunspot cycle the intensity rises to maximum and falls to minimum in about equal periods. Analogous conditions hold true in the case of the 10.7 cm radio noise flux. The results are in agreement with the Schmidt's work on sunspot numbers. (auth)

37336 THE ELECTRON DENSITY DISTRIBUTION IN THE LOWER IONOSPHERE PRODUCED THROUGH IMPACT IONIZATION BY PRECIPITATING ELECTRONS AND THROUGH PHOTOIONIZATION BY THE ASSOCIATED BREMSSTRAHLUNG X RAYS. Kamiyama, Hiroshi (Tohoku Univ., Sendai). J. Geomagnet. Geoelec., 19: 27-47(1967).

Characteristic features of the synthetic effect of a flux of precipitating mono-energy electrons are studied for the representative incident energies. The maximum rate of impact ionization produced by an electron flux of $2\pi \times 10^7$ cm^{-2} sec^{-1} is found to be about 1.7×10^3 cm^{-3} sec^{-1} at about the 116 km-level for the incident electron energy $E_0 = 10$ keV, and about 2.3×10^4 cm^{-3} sec^{-1} at about the 88 km-level for $E_0 = 100$ keV. On the other hand, the maximum rate of photoionization produced through the absorption of bremsstrahlung x rays caused by the same flux is about 3.6×10^{-2} cm^{-3} sec^{-1} at about 97 km for $E_0 = 10$ keV, and about 1.9×10^1 cm^{-3} sec^{-1} at about 45 km for $E_0 = 100$ keV. The consequent maximum electron density is estimated to be about 8.4×10^4 cm^{-3} at about 117 km for $E_0 = 10$ keV, and about 3.0×10^5 cm^{-3} at about 90 km for $E_0 = 100$ keV. In the latter case where $E_0 = 100$ keV, the electron density of the order of 10^3 cm^{-3} extends to a level as low as 65 km. The associated auroral luminosity is estimated to be 0.21 kR (kilo-rayleighs) at λ3914A, 0.14 kR at λ5577A, and 0.17 kR at λ6300A for $E_0 = 10$ keV; and 1.4 kR at λ3914A, 0.15 kR at λ5577A, and 0.046 kR at λ6300A for $E_0 = 100$ keV. Estimates are also made of the total effects of a flux of precipitating electrons having an energy spectrum expressed as $2\pi i_0 \exp(-E_0/\beta)$ at the top of the atmosphere. With $i_0 = 10^8$ cm^{-2} sec^{-1} keV^{-1} $ster^{-1}$ and $\beta = 5$ keV, the maximum electron density is found to be about 3.2×10^5 cm^{-3} at about 114 km. It is suggested that the electron flux of $2\pi \times 4.5 \times 10^4$ cm^{-2} sec^{-1} having such an energy spectrum would be required in order to explain the observed electron density in the nighttime E region at middle latitudes, as due to the influx of energetic electrons. (auth)

37337 EFFECT OF IONOSPHERIC IRREGULARITIES ON LATERAL DEVIATION OF RADIO WAVES REFLECTED FROM THE IONOSPHERE. Singh, R. N.; Misra, K. D. (Banaras Hindu Univ., India). Indian J. Pure Appl. Phys., 5: 66-7(Feb. 1967).

For certain ionospheric models, the angles of lateral deviation for radio waves propagating through the ionosphere are calculated. For a particular height, the lateral deviation and the lateral displacement of the magnetoionic components, due to an assumed inhomogeneity of electron density, are also calculated. It is found that the magnitude of lateral deviation increases with the degree of inhomogeneity in the electron density. The lateral deviation is found to be more for sunspot-maximum conditions and relatively less for sunspot-minimum conditions. It is suggested that the presence of ionospheric irregularities could be detected by a careful analysis of ionograms. (auth)

37338 AURORA AND AIRGLOW. Proceedings of the NATO Advanced Study Institute held at the University of Keele, Staffordshire, England, August 15–26, 1966. McCormac, Billy M. (ed.). New York, Reinhold Publishing Corp., 1967. 695p. $28.50. (CONF-660832).

The following topics are included in the lectures: worldwide morphology of airglow, magnetic field variations, dayglow observations, manned space-flight observations, electric fields, aurora and airglow observations from high-altitude nuclear detonations, radio observations, and fluorescent and resonant scattering. (J.H.M.)

Low-Temperature Physics

Refer also to abstract 36447.

37339 (BNL–50038) NATIONAL SUPERCONDUCTIVITY INFORMATION MEETING HELD AT BROOKHAVEN NATIONAL LABORATORY, NOVEMBER 9–11, 1966. ABSTRACTS OF

PAPERS. (Brookhaven National Lab., Upton, N. Y.). June 1967. 52p. Dep. CFSTI.

Abstracts are presented for 26 of the papers presented at the conference. (M.O.W.)

37340 (CEA-R-3242) THEORIE, ANALYSE ET APPLICATIONS DU FONCTIONNEMENT DU TRANSFORMATEUR SUPRACONDUCTEUR ALIMENTANT EN COURANT CONTINU UN CIRCUIT DE CHARGE SUPRACONDUCTEUR NON DISSIPATIF. (Theory, Analysis, and Applications of the Operation of the Superconducting Transformer Supplying a Direct Current to a Non-Dissipative Superconducting Charge Circuit). Sole, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). June 1967. 21p. (In French). Dep.

Very simple equations governing the operation of a transformer with superconducting windings supplying direct current to a non-dissipative superconducting charge circuit are derived. An analysis of the various possible modes of operation with direct or slowly varying current raises the problem of the magnetic core. The study leads to a conclusion which a priori might be surprising: the elimination of the magnetic core and the use of a primary superconductor. An example of a possible realization of such a transformer is given as an indication, and the present prospects for different applications are considered. (auth)

37341 (CEA-R-3243) STOCKAGE D'ENERGIE: POSSIBILITES DES SUPRACONDUCTEURS EN VUE DES DECHARGES DE GRANDES PUISSANCES. (Energy Storage: Possibilities of Superconductors for High Power Discharges). Sole, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). June 1967. 23p. (In French). Dep.

After briefly examining the various processes for energy storage and fast liberation, the new possibilities of superconductors in this field are considered. (auth)

37342 (ITF-67-1) CORRELATION FUNCTIONS IN THE THEORY OF SUPERCONDUCTIVITY. Bogoliubov, N. N. Jr. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 88p. Dep.

The asymptotically exact calculation of the free energy for the Bardeen-type model system is considered in detail, and the more complicated problems of estimating the differences between two correlation functions and between two Green functions are investigated, the latter being constructed on the basis of the model and the approximate Hamiltonians. (W.D.M.)

37343 (JINR-P1-3360) O VYYAVLENII IONOV V PEREOKHLAZHDENNYKH ZHIDKOSTYAKH. (On the Ion Detection in the Supercooled Liquids). Pisarev, A. F. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 12p. (In Russian). Dep.

It is shown by means of thermodynamic calculations that non-polar and weakly polar liquids as well as the liquids with isotropic electric polarizability must crystallize effectively on the ions or ion complexes in a supercooled state. The calculation of probability of crystal production on ions as nuclei in an impulse supercooled argon is given as an example. (auth)

37344 (MIT-3700-6) STABILITY AND SPATIALLY PERIODIC MAGNETIZATION OF HARD SUPERCONDUCTORS. Iwasa, Yukikazu (Massachusetts Inst. of Tech., Cambridge. Dept. of Electrical Engineering). May 1967. Contract AT(30-1)-3700. 145p. Dep. CFSTI.

Thesis.

The nature of flux jumping and associated phenomena, particularly the stability of hard superconductors, has been investigated. The most significant experimental result is the direct observation of the formation of the spatial periodicity of magnetization, viz., the macrovortex structure, in samples of magnetized unclad hard superconducting wire in ambient magnetic fields smaller than 35 kilogauss. A satisfactory explanation for the formation of macrovortices has been formulated. The formation of macrovortices involves a mechanism of energy concentration, in which the energy of magnetization stored uniformly over a finite volume is dissipated preferentially in a local region during the process of flux jumping, thereby raising the temperature of the region to the critical temperature. The balance of the energy of magnetization and the thermal energy associated with the change in temperature of the sample governs the process of flux jumping. The balance of these two energies is the principle that also applies to the interpretation of other experimental results, including those obtained from experiments on samples of copper-clad wire. Experiments have shown that macrovortices are apparently not formed in samples of copper-clad wire. The stability of hard superconductors has been investigated from the standpoint of their susceptibility to flux jumping. A quantitative criterion for their instability has been derived. In accordance with the criterion several metals have been examined as possible alternatives to copper as cladding materials for the suppression of flux jumping. It is found that it may be possible to stabilize a superconductor completely against flux jumping by the use of such metals as mercury or lead whose volumetric thermal capacity is much greater than that of copper. A smaller amount of these materials than of copper would be required to give a prescribed degree of stability to a superconductor. If flux jumping is completely eliminated, it should be possible to eliminate the phenomenon of current degradation. (auth)

37345 (N-67-17829) SUPERCONDUCTIVE MAGNETS AT LEWIS RESEARCH CENTER OF NASA. Laurence, James C. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). 1967. 22p. (NASA-TM-X-52269). CFSTI.

Construction details and performance data of special-purpose, superconductive magnets planned and in use at the Lewis Research Center of NASA are presented. The magnets described include: a pair of 2.5-tesla force-reduced toroids, 30 cm in diam with a winding cross section 2.5 cm in dia; a 15-cm-bore magnetic bottle with 5-tesla mirrors; a 2.5-tesla center coil, and a quadrupole Ioffe coil producing a cusp field; and a 6.25-cm-bore, 10-tesla solenoid. (auth) (STAR)

37346 (NP-16871) PERFORMANCE OF STABILIZED Nb-40 PERCENT Ti IN A HIGH CURRENT DENSITY 50 kG SUPERCONDUCTING SOLENOID. Research Report No. 270. El Bindari, A.; Bernert, R. E.; Hoppie, L. O. (Avco-Everett Research Lab., Everett, Mass.). May 1967. 13p.

A Nb-40% Ti alloy was successfully stabilized using OFHC copper as a stabilizing substrate. The composite superconducting material was 0.020" OD copper-clad wire containing .011" core of Nb-40% Ti. The method of production, the heat treatment to optimize the H-I characteristics of the alloy, and the mechanical properties are reported. The stabilization characteristics of the short sample are briefly discussed. The construction and the successful performance of a high overall current density ($\sim 2 \times 10^4$ amps/cm^2) superconducting solenoid producing ~50 kG in a $2\frac{3}{4}$-inch bore using Nb-40% Ti are fully discussed. (auth)

37347 (NP-16899) CRITICAL FIELDS, $Hc_2(T)$ AND $Hc_3(T)$, IN STRONG COUPLING SUPERCONDUCTORS. Technical Report No. 664. Yorke, Ellen D.; Bardasis, A. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Feb. 1967. 35p.

The Ginzburg-Landau equations are developed for a superconducting system with strongly retarded electron-phonon interactions. The resultant equations are then solved for two choices of phonon spectrum, the first being a simple Einstein one and the second being that of two Lorentzians. For comparison with experiment, parameters are chosen appropriate to the strong-coupling element, Pb. Solutions, with the aid of a computer, are obtained for the critical field $Hc_2(T)$ close to the critical temperature, T_c, for both the clean and dirty cases. Results are then compared with experiment. An automatic corollary of our G-L equations is that the ratio of the critical field, $Hc_3(T)$, associated with nucleation in a surface layer, to $Hc_2(T)$ is 1.7, the same as for weak-coupling superconductors. (auth)

37348 (NP-16937) GROUND-STATE OF SOLID ^{4}He AND ^{3}He. Hansen, Jean-Pierre; Levesque, Dominique (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). June 1967. 26p. (TH-205) Dep.

A variational calculation of the ground-state energy versus density curve for solid ^{3}He and solid ^{4}He at absolute zero is presented using a two-parameter "localized" Jastrow × gaussian trial wave function. The energy expectation value is calculated by a Monte Carlo method taking advantage of the formal analogy between the quantum variational problem integral and a classical canonical ensemble configuration integral. Results are in good agreement with experiment. The solid-liquid phase transition for both ^{3}He and ^{4}He is predicted to take place at densities close to the experimental ones. The Monte Carlo method was also used to test the validity of a variational calculation on a truncated cluster-expansion of the energy expectation value due to Nosanow. (auth)

37349 (ORNL-TM-1943) MAGNETIC FLUX FLOW AND SUPERCONDUCTOR STABILIZATION. Quarterly Report Covering the Period From April 1, 1967-June 30, 1967. Gauster, W. F.; Efferson, K. R.; Hendricks, J. B.; Kroeger, D. M.; Lubell, M. S. (Oak Ridge National Lab., Tenn.). Aug. 9, 1967. Contract W-7405-eng-26. 55p. Dep. CFSTI.

Flux flow experiments were made with a bare strip of superconducting Nb-25% Ti. Because of low pinning forces it was possible to observe the flux flow voltage in the full range of external fields from zero to 75 kG. Near H_{c2} pronounced peak effects could be observed. It does not seem to be possible to explain the take-off

points simply on the basis of the heat transfer to the helium bath. Current–voltage characteristics of a short sample of a stabilized Nb–Ti conductor were taken with currents up to 1340 A and with external fields up to 75 kG. Also, in this case, the take-off points were not simply related to the transition from nucleate to film boiling of the surrounding liquid helium. Since the resistance of the copper stabilizer at varying magnetic fields could be determined by means of recovery point measurements, it was possible to calculate the values of the current flowing through the superconductor at varying temperature and external fields. The temperature dependence proved to be linear in accordance with other published work. However, the field dependence measured here deviates from previous data. Some preliminary measurements of heat transfer from metal surfaces to liquid helium are discussed. Finally, for comparison, a review of a previous compound conductor stability criterion is presented. (auth)

37350 (UCRL–17550) INVESTIGATION OF HIGH FIELD SUPERCONDUCTING COMPOUNDS. Olson, Zelma Johnston (California Univ., Berkeley. Lawrence Radiation Lab.). May 1967. Contract W-7405-eng-48. 43p. Dep. CFSTI.

Thesis.

Only three β-Mn structures (interstitial compounds) are known to be superconductors, two of which were discovered at Berkeley. Compounds of this type appear to have excellent potential as high-field materials, when judged by a comparison of upper critical field to transition temperature. A review of the crystal structure and superconductivity of β-Mn structure compounds is presented here, along with a report of the discovery of a new superconductor in this structure (the third of the group mentioned above). The new compound is W_3Re_2C, which has a T_c of 7.4°K. A discussion of the electron-to-atom ratio as applied to these filled interstitial alloys is also included. The behavior of commercial hard superconductors is extremely sensitive to microstructure and the improvement of superconducting properties of transition metal alloys by controlled microstructure has recently become very important. A study of the effect of microstructure in two phase compounds and alloys of transition metals is presented. One result has been the synthesis of a two phase high-field superconductor with filamentary microstructure (Nb_3Sn in a NbC matrix, critical field higher than 200 kG at low current densities). A second significant accomplishment was the increase of the superconducting transition temperature of Ta–50% Zr alloys by controlling the formation of the precipitate within the miscibility gap composition range of the Ta–Zr system. (auth)

37351 SUPERFLUID DENSITY IN SMALL PORES. Rudnick, I.; Guyon, E.; Shapiro, K. A.; Scott, S. A. (Univ. of California, Los Angeles). Phys. Rev. Lett., 19: 488-90(Aug. 28, 1967).

The superfluid density in small pores filled with He II has been measured using fourth sound. When the onset temperature for superfluidity is below T_λ, it is found that the fractional superfluid density is much reduced compared to that of the bulk helium. (auth)

37352 SUPERFLUIDITY IN FINITE SYSTEMS: PROPAGATION OF FOURTH SOUND AND THE DENSITY OF SUPERFLUID. Brewer, D. F. (Univ. of Sussex, Eng.); Leppelmeier, G. W.; Lim, C. C.; Edwards, D. O.; Landau, J. Phys. Rev. Lett., 19: 491-4 (Aug. 28, 1967).

Measurements have been made of the fractional density of superfluid, ρ_s/ρ, in helium II contained in micropores (average radius ~31 Å), as calculated from fourth-sound measurements between 1.2 and 2°K. Since the lambda transition is greatly modified in this system, the temperature variation of ρ_s/ρ may generally be expected to differ from that in "infinite" bulk liquid, at least near the transition temperature. The results lead to the conclusion that the critical velocity in such channels decreases rapidly with increasing temperature above 1.2°K. (auth)

37353 HYPERSONIC ATTENUATION IN SUPERCONDUCTING MERCURY AT 9 GHz. Ferguson, R. B.; Burgess, J. H. (Washington Univ., St. Louis). Phys. Rev. Lett., 19: 494-5(Aug. 28, 1967).

Measurements of the attenuation of longitudinal ultrasound in polycrystalline superconducting mercury at a frequency of about 9.3 GHz are reported. (M.O.W.)

37354 TRANSITION TEMPERATURE OF Pb–In AND Pb–Tl ALLOYS. Wu, T. M. (Western Reserve Univ., Cleveland). Phys. Rev. Lett., 19: 508-10(Aug. 28, 1967).

The ratio between the energy gap parameter at zero temperature and the transition temperature is evaluated for Pb–In and Pb–Tl alloys. (M.O.W.)

37355 MOBILITY OF ELECTRONS IN LIQUID ^{3}He AT THE CRITICAL POINT. Modena, I. (Comitato Nazionale per l'Energie Nucleare, Rome); Ricci, F. P. Phys. Rev. Lett., 19: 347-50 (Aug. 14, 1967).

Some experimental results on the mobility of electrons in liquid ^{3}He at the critical point are reported. The experimental apparatus is shown and the results are given. It is concluded that the mobility, and therefore the diffusion coefficient, undergoes a small decrease (~30%) in the critical region but does not seem to go to zero. (W.D.M.)

37356 PHASE SEPARATION AND THE SUPERFLUID TRANSITION IN LIQUID ^{3}He–^{4}He MIXTURES. Graf, E. H.; Lee, D. M.; Reppy, John D. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett., 19: 417-19(Aug. 21, 1967).

The phase-separation and superfluid-transition temperatures of ^{3}He–^{4}He liquid mixtures have been investigated as functions of ^{3}He concentration under conditions of saturated vapor pressure by means of dielectric-constant and thermal-equilibrium time-constant measurements. The λ line, which divides the normal and superfluid phases in the temperature–concentration plane, is found to intersect the phase-separation curve at its peak. (auth)

37357 QUASI PARTICLE SELF-ENERGY AND SPECIFIC HEAT OF A FERMI LIQUID: APPLICATION TO ^{3}He. Amit, D. J.; Kane, J. W.; Wagner, H. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett., 19: 425-8(Aug. 21, 1967).

The contribution of particle–hole excitations to the single-particle self-energy of a Fermi liquid at zero temperature is calculated. The results are applied to liquid ^{3}He. (M.O.W.)

37358 PROPERTIES OF SUPERCONDUCTORS HAVING OVERLAPPING BANDS. Geilikman, B. T.; Zaitsev, R. O.; Kresin, V. Z. (Moscow State Correspondence Pedagogical Inst.). Sov. Phys.-Solid State (Engl. Transl.), 9: 642-7(Sept. 1967).

Translated from Fiz. Tverd. Tela, 9: 822-9(Mar. 1967).

The properties of superconductors having overlapping bands are considered. The details of Cooper pairing in such samples are discussed. Equations are obtained for the heat capacity, critical field, the system of Ginzburg–Landau equations, and the ultrasonic attenuation coefficient. The nature of many-band effects can be observed only in pure superconductors, which allows them to be distinguished in a unique way. (auth)

37359 DILUTE SOLUTIONS OF ^{3}He IN ^{4}He AT LOW TEMPERATURES. Massey, Walter E. (Argonne National Lab., Ill.); Woo, Chia-wei. Phys. Rev. Lett., 19: 301-5(Aug. 7, 1967).

The method of correlated basis functions is applied to dilute solutions of ^{3}He in ^{4}He at low temperatures. An outline of the microscopic calculation is presented, as well as some preliminary results. (M.H.R.)

37360 DENSITY OF ^{4}He NEAR THE CRITICAL POINT. Roach, Pat R.; Douglass, D. H. Jr. (Univ. of Chicago). Phys. Rev. Lett., 19: 287-90(Aug. 7, 1967).

The density of ^{4}He was measured along five isotherms near the critical point. Using a modified form of the power-law expression $|P-P_c| \propto |\rho-\rho_c|^\delta$ for the critical isotherm, $3.8 \leq \delta \leq 4.1$ is obtained. Assuming that the specific heat follows a relation $C_v \propto |T-T_c|^{-\alpha'}$ and that the density of the coexistence curve behaves as $|\rho-\rho_c| \propto (T_c-T)^\beta$, previous measurements for α' and β allow to test Griffith's inequality $\beta(\delta+1)+\alpha' \geq 2$. A maximum value for $\beta(\delta+1)+\alpha'$ of 1.9 is found. (auth)

37361 TEMPERATURE DEPENDENCE OF SUPERFLUID CRITICAL VELOCITIES NEAR T_λ. Clow, James R.; Reppy, John D. (Yale Univ., New Haven). Phys. Rev. Lett., 19: 291-3 (Aug. 7, 1967).

Persistent-current methods are used to obtain critical-velocity data for flow of superfluid helium through filter materials with uniform pore size. For the smallest pore size investigated, 0.2 μ, evidence is seen for a small depression (7.5×10^{-4}K) of the transition temperature. The critical velocity for this pore size is found to vary linearly with the superfluid density as the transition temperature is approached. (auth)

37362 HIGH-FIELD GALVANOMAGNETIC PROPERTIES OF NIOBIUM AND TANTALUM. Fawcett, E.; Reed, W. A.; Soden, R. R. (Bell Telephone Labs., Inc. Murray Hill, N. J.). Phys. Rev., 159: 533-9(July 15, 1967).

The galvanomagnetic properties of niobium and tantalum were measured at 4.2°K in fields up to 100 kG for single crystals having residual resistivity ratios of 1500 (niobium) and ~10,000 (tantalum). The two metals exhibit very similar anisotropy of their galvanomagnetic properties. Each is uncompensated, with a net number of carriers equal to one hole per atom. The strong anisotropy of the magnetoresistance results from open orbits on a surface which is topologically similar to a set of intersecting cylinders along the cube axes. Measurements of the Hall coefficient with the field along the symmetry axes show this to be an open hole surface, and provide a measure of two of its dimensions. This surface is con-

sistent with that proposed by Mattheiss for the group-VB metals on the basis of his energy-band calculations for tungsten. (auth)

37363 POSSIBLE RELATION BETWEEN PHASE SEPARATION AND THE λ TRANSITION IN ^{3}He–^{4}He MIXTURES. Rice, O. K. (Univ. of North Carolina, Chapel Hill). Phys. Rev. Lett., 19: 295-7(Aug. 7, 1967).

Along the λ line in ^{3}He–^{4}He mixtures, the specific heat at constant chemical potential presumably becomes infinite. It is suggested that the λ transition changes over to a first-order transition at a point at which the specific heat at constant composition becomes infinite. Possible reasons for such a change are discussed. The thermodynamic relationships are introduced through analogy with a system in which the variables are pressure and volume rather than chemical potential and composition. (auth)

37364 USE OF A JOULE–THOMSON REFRIGERATOR FOR NEUTRON DIFFRACTION AT LIQUID NITROGEN TEMPERATURES. Coppens, P.; Godel, J.; Sabine, T. M. (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instrum., 38: 1333-4(Sept. 1967). (BNL-11341).

A cryostat for neutron diffraction is described that makes use of the expansion of high-pressure nitrogen gas and can be operated in any position, while the beam can reach the specimen crystal unobstructed through a complete hemisphere. Several measurements of the 200 reflection of NaCl alternately at room and liquid nitrogen temperature show that the results are completely reproducible, independent of the number of temperature cycles. (L.B.S.)

37365 CRYOSTAT FOR STUDIES AT ~100 KILOBARS AT LIQUID HELIUM TEMPERATURES. Lyon, D. N. (Univ. of California, Berkeley). Rev. Sci. Instrum., 38: 1234-40(Sept. 1967).

A cryostat to transmit the load of a 270-ton press to a chamber at liquid helium temperatures is described. The pressure transmitting columns are made of an epoxy resin-bonded glass fiber laminate. The liquid helium consumption is ~10 liters to cool from ~70 to 4.2°K, and the boiloff rate is ~1.2 liters. Measurements of the electrical resistance of bismuth between 4.2 and 77°K at different pressures up to ~85 kilobars were made using a Bridgman anvil (1.27 cm face) geometry. (auth)

37366 METHOD FOR EVALUATING THE STABILITY OF COMPOSITE SUPERCONDUCTORS. Purcell, J. R.; Brooks, J. M. (Argonne National Lab., Ill.). J. Appl. Phys., 38: 3109-11(July 1967).

Data are presented for tests conducted on Nb–33% Zr superconducting cable. The method of testing is described; it provides a reliable method for predicting the maximum stable current and field that can be expected for a magnet wound from the cable. (auth)

37367 INVESTIGATION OF THE EFFECT OF PRESSURE UP TO 30 KATM ON THE CRITICAL FIELD OF TIN AND INDIUM AT TEMPERATURES OF 0,1 TO 4°K. Berman, I. V.; Brandt, N. B.; Ginzburg, N. I. (Moscow State Univ.). Zh. Eksp. Teor. Fiz., 53: 124-33(July 1967). (In Russian).

The effect of pressures up to 30 katm on the critical fields of tin and indium is investigated in the temperature range between 0.1 and 4°K. It is found that in a first approximation the magnitude of the deviation of the critical field curves from parabolicity is the same throughout the indicated pressure range. This circumstance is used for calculating the dependence of the state density N_0 on the Fermi surface on the pressure and the dependence of the electron–phonon interaction parameter V on pressure by employing the BCS formula. In tin, lowering of the superconducting transition temperature T_c due to compression occurs at the expense of decrease of N_0, the parameter V remaining the same within the accuracy of the measurements. In indium, besides a decrease of N_0 which shows up at pressures above 10 katm, a noticeable decrease of the parameter V is observed which is of the order of 5% at a pressure of about 28 katm. (auth)

37368 SURFACE SUPERCONDUCTIVITY IN THIN CYLINDERS. Doll, Robert; Graf, Peter (Kommission fuer Tieftemperaturforschung, Munich). Z. Phys., 204: 205-10(1967). (In German).

Solutions of the nonlinear Ginsburg-Landau equations in cylindrical symmetry were computed with a fluxoid quantum number n = 5 in the case of surface superconductivity for a type-I superconductor. Gibbs free energy and magnetization as functions of the magnetic field are given for two values of the radius of the cylinder. (auth)

37369 MINIMAL THEORY OF ULTRASONIC ATTENUATION IN SUPERCONDUCTORS. Ferrell, Richard A. (Univ. of Maryland, College Park). Physics, 3: 157-9(June 1967).

The conventional formula for ultrasonic attenuation of longitudinal waves in superconductors is usually derived from the coherence factors of the BCS theory. It is noted that this formula has in actuality a much more general foundation. With an alternative deformation potential approach, the detailed properties of the superconductor do not enter and the result depends only upon the minimum energy in the spectrum of the elementary excitations. (auth)

37370 ZERO-FIELD NUCLEAR SPIN RELAXATION AND RESONANCE ABSORPTION IN SUPERCONDUCTING ALUMINUM. MacLaughlin, D. E.; Hahn, E. L. (Univ. of California, Berkeley). Phys. Rev., 159: 359-68(July 10, 1967).

Several field-cycling spin-relaxation experiments have been carried out on ^{27}Al nuclei in normal and superconducting aluminum metal. Information has been obtained on magnetic-field motion during transition from the normal to the superconducting state. Audio-frequency nuclear resonance absorption at zero external dc field was observed in the superconducting state from 0.56 to 1.2°K. The dependence of this absorption upon the amplitude and duration of the audio-frequency field indicates that the major absorption occurs in the London penetration region. The resonance absorption signal decreases in proportion to ln α in the superconducting state, compared to $e^{-\alpha}$ in the normal state, where the absorption parameter α is a function of audio-frequency field intensity, frequency, and time of application. The magnitude of the absorption indicates that the nuclear spin order is concentrated in a sheath of thickness $a_0 \approx 10^{-5}$ to 10^{-4} cm near the surface of the sample, and is created during the normal-to-superconducting phase change initiated by reducing the external magnetic field from above the critical value to zero. Nuclear order in the bulk of the sample is lost because of the rapid Meissner-effect flux expulsion during the demagnetization. The ordered sheath is a consequence of nearly adiabatic field variation during surface nucleation of the superconducting phase. The temperature variation of a_0 was measured. An apparent decrease in a_0 near the transition temperature is tentatively attributed to additional audio-frequency nuclear absorption in regions of trapped flux. (auth)

37371 ANOMALOUS SPECIFIC HEAT OF SUPERCONDUCTING MAGNETIC ALLOYS. Bennemann, K. H. (Univ. of Chicago); Garland, J. W. Phys. Rev., 159: 369-73(July 10, 1967).

The specific heat of superconductors containing small concentrations of paramagnetic impurities is calculated. It is shown that ordering of the impurity spins gives rise to a large enhancement of the specific heat and changes strongly the dependence of the electronic specific-heat discontinuity at the superconducting transition temperature on the concentration of paramagnetic impurities. It is pointed out that the impurity-spin ordering in a superconductor is affected by nonmagnetic impurities. (auth)

37372 MICROWAVE PHOTON INTERACTION WITH SUPERCONDUCTING TUNNELING CURRENTS. Cook, Charles F. (Naval Ordnance Lab., Corona, Calif.); Everett, Glen E. Phys. Rev., 159: 374-82(July 10, 1967).

The photon-assisted tunneling, originally observed by Dayem and Martin, was remeasured for Al/In junctions and extended to Sn/Pb junctions. Particular attention has been devoted to obtaining detailed quantitative measurements of the current I and the conductance dI/dV versus voltage and for various microwave power levels. In addition to the steps in the tunneling current at $eV_0 = \Delta_1 + \Delta_2 \pm n\hbar\omega$ observed by Dayem and Martin, an additional set at $eV_0 = \Delta_2 - \Delta_1 \pm n\hbar\omega$ was observed. It is concluded that the phase shift in peak position above the tunneling edge is from an almost exact superposition of these two sets of peaks, a consequence of the near coincidence of the microwave photon energy and one-half the energy gap of indium. A detailed comparison of the results with the theory of Tien and Gordon gives good agreement as to peak positions and shapes while the dependence of peak amplitude on microwave power level is poor, particularly at higher power levels. The Tien and Gordon theory was extended to provide for a modulation of the density of states in both superconductors and the tunneling current was recalculated. The agreement with experiment is good, in particular, the nonvanishing of the conductance for any value of the microwave power is accounted for. (auth)

37373 HYSTERESIS IN SUPERCONDUCTORS. I. FLUX TRAPPING IN LOW- and HIGH-κ MATERIALS. Schweitzer, Donald G.; Garber, M.; Bertman, B. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-32)-Gen-16. Phys. Rev., 159: 296-300(July 10, 1967). (BNL-10926).

Flux-trapping properties of type-II superconductors are described. A linear relationship between the remnant magnetization and the internal field is observed in the low-κ superconductors but not in Nb_3Sn and Nb_3Zr. It was found that the linear relationship and the associated slopes are to a large extent independent of much of the bulk and are related to surface currents. In addition, the linear relationships are observed only in low-κ superconductors that exhibit appreciable diamagnetic behavior. (auth)

37374 SUPERCONDUCTIVE PROPERTIES OF CERAMIC MIXED TITANATES. Schooley, J. F.; Frederikse, H. P. R.; Hosler, W. R.; Pfeiffer, E. R. (National Bureau of Standards, Washington, D. C.). Phys. Rev., 159: 301-5(July 10, 1967).

The superconducting transition temperatures of a series of mixed barium–strontium and calcium–strontium titanate ceramic specimens have been determined. For several of these samples the low-field magnetization has also been investigated. The results are compared with those obtained from single-crystal $SrTiO_3$. (auth)

37375 FLUCTUATIONS OF THE ORDER PARAMETER IN TYPE-II SUPERCONDUCTORS. I. DIRTY LIMIT. Caroli, Christiane; Maki, Kazumi (Univ. of California, San Diego, La Jolla). Phys. Rev., 159: 306-15(July 10, 1967).

The time dependence of fluctuations of the order parameter in dirty type-II superconductors was studied in the high-field region ($H \simeq H_{c2}$). In this domain their dispersion relation can be calculated without taking into account the other collective modes (i.e., density and current oscillations), since the coupling of these oscillations with the order-parameter fluctuations is small (i.e., of the order of Δ, which vanishes at $H = H_{c2}$). Among many modes the following two are of special interest: the longitudinal mode, which couples to the density oscillations, and the transverse mode, which couples to the current oscillations. The longitudinal mode is of diffusion type at all temperatures. The transverse one is essentially damped, except in the vicinity of T_{c0} (critical temperature in zero field), where it is also diffusionlike. The thermal conductivity, ultrasonic attenuation, and spin susceptibility are not affected by the existence of these fluctuations. The transverse conductivity, which is strongly modified, was calculated showing an important anisotropy, which should be easily seen in surface-impedance measurements. (auth)

37376 FLUCTUATIONS OF THE ORDER PARAMETER IN TYPE-II SUPERCONDUCTORS. II. PURE LIMIT. Caroli, Christiane; Maki, Kazumi (Univ. of California, San Diego, La Jolla). Phys. Rev., 159: 316-26(July 10, 1967).

The fluctuations of the order parameter in pure type-II superconductors were studied in the vicinity of the upper critical field H_{c2}, where the equilibrium value of the order parameter $\Delta(r)$ is described in terms of the Abrikosov solution. Among many fluctuations two modes were concentrated on: (1) The longitudinal mode, which couples to the density fluctuations. This mode is described by an equation of diffusion type at all temperatures. The diffusion coefficient is weakly temperature-dependent and given by $D \cong \xi_0 v^2$, where ξ_0 is the coherence distance and v the Fermi velocity. (2) The transverse mode, which couples to the current fluctuations. At high temperature (i.e., $T \sim T_{c0}$, where T_{c0} is the critical temperature in zero field) this mode is of diffusion type, while at low temperature, it becomes a strongly damped oscillation. It is shown that the transverse modes cause an important modification of the electromagnetic response of the type-II superconductor. When the oscillating current flows in the plane perpendicular to the static magnetic field, the reactive part of the resulting response vanishes identically at low frequency (i.e., $\omega < T_{c0}$). This modifies strongly both the surface impedance and the attenuation coefficient of a transverse ultrasonic wave in the corresponding geometry. (auth)

37377 SUPERCONDUCTIVITY OF THE TRANSITION-METAL CARBIDES. Willens, R. H.; Buehler, E.; Matthias, B. T. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 159: 327-30 (July 10, 1967).

By rapid quenching from the melt, solid solutions having the NaCl-type structure can be obtained between binaries of NbC, TaC, WC, and MoC. The superconducting transition temperatures of these pseudobinaries were investigated. The experimental results were consistent with the interpretation that the density of states at the Fermi surface is probably flat and that stoichiometry is the main factor for achieving the maximum in the superconducting transition temperature. Apparently, as the stoichiometry is improved, the attractive phonon interaction between electrons V_{ph} increases. (auth)

37378 MIXED STATE OF THIN SUPERCONDUCTING FILMS IN PERPENDICULAR FIELDS. Fetter, Alexander L. (Stanford Univ., Calif.); Hohenberg, P. C. Contract AF49(638)-1389. Phys. Rev., 159: 330-43(July 10, 1967).

The behavior of ideal thin superconducting films in perpendicular magnetic fields is studied in detail and related to that of bulk type-II superconductors. A macroscopic analysis based only on the demagnetizing factors yields the dominant effects of sample geometry on the reversible magnetization curve. The same features are also derived from Pearl's generalization of Abrikosov's microscopic model, which predicts a long-range interaction between quantized flux lines in a thin film. Comparison of the macroscopic and microscopic arguments clarifies some inaccuracies in the work of Pearl and of Maki. The dependence of critical magnetic fields in film thickness is discussed for different values of the Ginzburg–Landau parameter κ. A hydrodynamic calculation demonstrates that a triangular vortex lattice is stable against small perturbations in the long-wavelength limit ($qn^{-\frac{1}{2}} \ll 1$); for $n^{\frac{1}{2}}\Lambda \gg 1$, the corresponding dispersion relation is $\omega = \frac{1}{4}(eB/mc)q^{\frac{1}{2}}\Lambda^{\frac{1}{2}}(n\pi)^{-\frac{1}{4}}$, where n is the vortex density, $\Lambda \equiv 2\lambda^2/d$ is the "effective penetration depth," λ is the actual penetration depth, and d ($\ll\lambda$) is the film thickness. This conclusion disagrees with Pearl's conjecture based on elasticity theory; the long-range interaction precludes the use of elasticity theory, as is seen from the difference between the calculated dispersion relation ($\omega \propto q^{\frac{1}{2}}$) and that predicted for elastic modes ($\omega \propto q^2$). The dynamics of vortex systems is contrasted with the Newtonian dynamics of point masses. In practice, thin films exhibit highly irreversible behavior, and no detailed comparison between theory and experiment is attempted. (auth)

37379 CRITICAL FIELDS $H_{c3}(T)$ AND $H_{c3}(T)$ IN STRONG-COUPLING SUPERCONDUCTORS. Yorke, Ellen D.; Bardasis, A. (Univ. of Maryland, College Park). Phys. Rev., 159: 344-52 (July 10, 1967).

The Ginsburg–Landau (G–L) equations are developed for a superconducting system with strongly retarded electron–phonon interactions. The resultant equations are then solved for two choices of phonon spectrum, the first being a simple Einstein one and the second being that of two Lorentzians. For comparison with experiment, parameters are chosen appropriate to the strong-coupling element Pb. Solutions are obtained with the aid of a computer for the critical field $H_{c2}(T)$ close to the critical temperature T_c for both the clean and dirty cases. Results are then compared with experiment. An immediate corollary of our G–L equations is that the ratio of the critical field $H_{c3}(T)$, associated with nucleation in a surface layer, to $H_{c2}(T)$ is 1.7, the same as for weak-coupling superconductors. (auth)

37380 WILL PRESSURE DESTROY SUPERCONDUCTIVITY? Smith, T. F.; Chu, C. W. (Univ. of California, San Diego, La Jolla). Phys. Rev., 159: 353-8(July 10, 1967).

The question of whether the application of sufficient pressure can destroy superconductivity completely is considered for the superconductors Al, Cd, Zn, In, Sn, and Pb. The superconducting transition temperature T_c for these elements is found to vary linearly with volume over an appreciable range of volume. Extrapolation to $T_c = 0$ yields critical pressures of 67, 38, and 41 kbar for the destruction of superconductivity in Al, Cd, and Zn, respectively. These values are compared with considerably higher estimates obtained in previous analyses. Measurements of T_c for lead, as a function of pressure up to a maximum pressure of 30 kbar, are presented. On combining these data with Bridgman's room-temperature compressibility measurements for lead, T_c is found to vary linearly with volume and $\partial T_c/\partial V = 0.907°K\ cm^{-3}$, corresponding to $\partial T_c/\partial P = -3.86 \pm 0.12 \times 10^{-5}K\ bar^{-1}$ at P = 0. (auth)

37381 THERMODYNAMICS OF TWO-BAND SUPERCONDUCTORS WITH NON-MAGNETIC IMPURITY. Moskalenko, V. A. (Inst. of Mathematics and Computer Center, Mold SSR). Fiz. Metal. Metalloved., 23: 585-96(Apr. 1967). (In Russian).

Basic thermodynamic equations were obtained for superconductors with a nonmagnetic impurity. It is shown that at zero temperature the parameters of the order–disorder transformation Γ_n are reduced proportionally with the concentration of the nonmagnetic impurity added to the superconductor. At large impurity concentration the parameters continue to diminish according to the power law. The Γ_n magnitude was estimated at the critical temperature T_c and an expression was obtained for the thermodynamic potential at T_c. It was found that at high concentration of nonmagnetic impurity all thermodynamic magnitudes are practically identical to the corresponding one-region pure substance; the only difference is that T_c is determined on the two-region basis under the condition that the density of the one-region substance n is replaced by the sum of densities $N_1 + N_2$. (tr-auth)

37382 THEORY OF AUTOELECTRON EMISSION IN SUPERCONDUCTORS. Gogadze, G. A.; Kulik, I. O. (Physical-Technical Inst. of Low Temperatures, Kharkov). Fiz. Metal. Metalloved., 23: 606-15(Apr. 1967). (In Russian).

The total energy distribution and its normalized component were calculated for electrons emitted by superconductors. The two functions obtained differed considerably from the corresponding functions of the normal metal near the narrow Fermi lead range. At the same time the total change in the autoelectron current during the transition of the metal from normal to the superconducting state is very slight. (R.V.J.)

37383 EFFECTS OF THE DEGREE OF METAL LATTICE DEFORMATION ON THE SUPERCONDUCTIVITY OF THE METAL.

Lazarev, B. G.; Semenenko, E. E.; Kuz'menko, V. M. (Physical-Technical Inst., Tashkent). Fiz. Metal. Metalloved., 23: 651-4 (Apr. 1967). (In Russian).

Effects of the crystalline lattice deformation on the critical temperature (T_c) and critical fields (H_c) in superconducting layers of lead and aluminum were studied. In freshly condensed layers $(dH_c/dt)/T_c$ reached 7000 Oe/grad in Pb and 30,000 Oe/grad in Al. The functions $H_{\theta(\rho)}$ for Pb are a saturation curve which corresponds to the ~22,000-Oe fields. Effects of crystalline lattice deformation on T_c in aluminum are very high and negligible in lead. (R.V.J.)

37384 MEASUREMENTS OF LOSSES IN TYPE-II SUPERCONDUCTORS IN THE ALTERNATING REGIME. Huret, J. (Centre de Recherches de la CGE, Marcoussis, France). Rev. Phys. Appl., Suppl. J. Phys., 2: 133-6(June 1967). (In French).

When an ac current passes through a superconducting wire of the second kind placed in an ac or dc magnetic field, thermal losses appear in the wire. A method was set up to measure those losses and to note their variations versus some relevant parameters in order to try and approach a model which represents the physical mechanism which is the source of the losses. (auth)

37385 FLUX PENETRATION IN TYPE-II SUPERCONDUCTORS. Takacs, S. (Elektrotechnisches Institut, Bratislava). Phys. Status Solidi, 21: 709-16(June 1, 1967). (In German).

It is shown that in a macroscopic type-II superconductor the formation of flux threads is energetically favorable far below the thermodynamic critical field and that the "pure" surface barrier then becomes inefficient. For the half-space, the field strength for the appearance of flux threads is given together with values for the maximum penetration field. In the appendix, maximum values are added for the penetration fields of a thin hollow cylinder. (auth)

37386 COLLECTIVE MODES OF A SPIN-DENSITY-WAVE STRUCTURE. Fano, G. (Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna); Pizzichini, G. Phys. Rev., 160: 219-25(Aug. 5, 1967).

The collective modes of a spin-density-wave structure are investigated in a one-dimensional model of a Fermi gas. The equations of motion in the random-phase approximation are completely solved at zero temperature and for a δ-function interaction. The spin-density-wave structure has been found to be stable if its wavelength is equal to its best variational value. The complete dependence of the energy ω(q) of the collective modes on the momentum q is exhibited. A new result is found and proved rigorously: The energy ω(q) vanishes when $2\pi/q$ is equal to the wavelength of the spin-density wave. (auth)

37387 DISTRIBUTION FUNCTIONS OF A HARD-SPHERE FERMI GAS. Isihara, A.; Gupta, Arun K. (State Univ. of New York, Buffalo). Phys. Rev., 160: 225-36(Aug. 5, 1967).

The singlet and pair distribution functions of a Fermi gas are evaluated for low temperatures. It is assumed that the particles interact with a hard-sphere potential and have an arbitrary spin, and the evaluation is made to first order in the hard-sphere diameter. The binary-kernel method developed by Siegert, Lee, and Yang is used and the cluster-expansion theory given recently by Isihara and Yee for the distribution functions is applied. The pair distribution function is determined by a dimensionless variable r/λ, with λ being the thermal de Broglie wavelength. Thus, changing the distance corresponds to varying the temperature. Moreover, the pair distribution function depends on the density. Therefore, its asymptotic expression for $T \to 0$ depends on the ways to approach the limit. If one keeps the density finite and reduce the temperature, the gas will be degenerate when λ is of order of $n^{-1/3}$, where n is the number density. The pair distribution function for this case is an oscillating function of the Fermi momentum. On the other hand, if one reduces the density first and then decreases the temperature, the pair distribution function decays as r^{-4}, and the free-particle diagrams give a contribution of the same decay. (auth)

37388 INFLUENCE OF THE REPULSIVE CORE ON THE CALCULATED PROPERTIES OF LIQUID ^{3}He. Campbell, L. J. (Univ. of Illinois, Urbana). Phys. Rev., 160: 236-43(Aug. 5, 1967).

Using a simple form of Brueckner's theory, the ground-state (zero-temperature) properties of normal liquid ^{3}He are calculated at two densities as functions of the radius of a repulsive hard core in the ^{3}He interatomic potential. The effect of the attractive part of the "6-12" potential is treated in low order. The results for the binding energy, pressure, ordinary sound velocity, thermal expansion, viscosity, thermal conductivity, spin diffusion, effective mass, and susceptibility are strongly dependent on the hard-core radius r_c, the latter two being singular in r_c. Six of the properties achieve their experimental values for $r_c \approx 1.8$ Å. The results suggest that the repulsive region of the He potential should be accurately known before quantitative success of microscopic calculations can be expected. An argument is presented showing the difficulty of obtaining the correct binding energy of liquid ^{3}He from a theory of the Brueckner type. (auth)

37389 MECHANICAL ENERGY DENSITY OF SECOND SOUND IN LIQUID HELIUM II. Metz, Claire D. (Columbia Univ., New York); Boorse, Henry A.; Herrey, Erna M. J. Phys. Rev., 160: 244-9(Aug. 5, 1967).

The mechanical energy density in a second-sound beam was determined experimentally between 1.2°K and the lambda point by measuring the force that the beam exerts on the vane of a torsion balance. At low power input, the experimental energy density conforms to the expression $E = (\rho C T u_2^2)^{-1} \langle \dot{Q}^2 \rangle_{av}$ derived from low-velocity nondissipative two-fluid theory. At higher power input the experimental values are too low. The discrepancy does not seem to arise from large amplitude effects in the second-sound wave. The temperature and power dependence of the observed attenuation is approximately the same as in Vinen's experiment on the attenuation of second sound propagated across a steady heat current in a tube. Vinen shows that the attenuation is caused by turbulence in the heat current, although the exact nature of the turbulence and the role played by tube diameter and surface imperfections of the tube walls is still controversial. It appears that in the present experiment the attenuation also results from scattering of second sound by turbulence in a heat current. This heat current arises from the dc component of the heat input to the second-sound source, and it flows freely through the bulk liquid, in the same direction as the second-sound beam. Since the observed attenuation is essentially the same as in Vinen's experiment, it is reasonable to conclude that the turbulence is approximately isotropic and that tube diameter and wall effects are not decisive factors for nucleation and growth of turbulence in a heat current in helium II. (auth)

37390 NOTE ON THE TWO-BODY CORRELATION APPROXIMATION IN LIQUID ^{3}He. Beck, Donald E. (Univ. of California, San Diego, La Jolla). Phys. Rev., 160: 250-8(Aug. 5, 1967).

A calculation was made earlier of the low-temperature properties of liquid ^{3}He in the thermodynamically consistent "T-matrix" (TCTM) approximation, and presented a preliminary, zero-temperature calculation employing a separable potential and non-interacting spectral functions. This program is continued by calculating, with the local Phillipson–Morse–Dalgarno (PMD) potential of Bernstein and Morse, the zero-temperature properties at a single Fermi momentum. A calculation employing noninteracting spectral functions is performed as the zeroth-order solution of the complete TCTM approximation. The calculated properties differ from those obtained in the earlier calculation, and the difference is understood by comparing de Boer's 6-12 potential to which the separable potential was fitted with the PMD potential. Using the zeroth-order solution as input, an iterative solution of the coupled integral equations of the TCTM approximation is obtained. The convergence of the iterative procedure is rapid, and a spectral function for the interacting system is obtained. The calculated properties do not agree with the experimentally determined properties, but a TCTM approximation using an interatomic potential in better agreement with the second-virial-coefficient data for helium than the PMD potential is expected to produce results in better agreement with experiment. (auth)

37391 QUANTUM THEORY OF THE SMALL JOSEPHSON JUNCTION. Scott, A. C. (Univ. of Wisconsin, Madison). Phys. Lett., 25A: 132-3(July 31, 1967).

A lossless, small-area Josephson junction is analyzed from the point of view of quantum dynamics. Schroedinger's equation in the flux representation reduces to Mathieu's equation. (auth)

37392 DESTRUCTION OF SUPERCONDUCTIVITY BY A CURRENT. Baird, D. C.; Mukherjee, B. K. (St. Andrews Univ., Scotland). Phys. Lett., 25A: 137-8(July 31, 1967).

A revised form of the London theory of the destruction of superconductivity by a current is presented. Numerical methods are used to find the optimum phase boundary configuration. The result specifies the scale of the structure and the resistance of the intermediate state. (auth)

37393 FLUX-HOLE MOTION AND THE PEAK EFFECT IN SUPERCONDUCTIVITY. Maxwell, E.; Schwartz, B. B.; Wizgall, H. (Massachusetts Inst. of Tech., Cambridge). Phys. Lett., 25A: 139-40(July 31, 1967).

The resistive behavior of type II superconductors in the neighborhood of the "peak effect" is described in terms of the motion of holes in the flux-lattice. (auth)

37394 FREQUENCY EFFECT IN THE ULTRASONIC ATTENUATION IN NIOBIUM IN THE MIXED STATE. Ikushima, A.; Kajimura, K.; Akao, F. (Osaka Univ.). Phys. Lett., 25A: 151-2(July 31, 1967).

Attenuation of longitudinal ultrasonics of various frequencies was measured in niobium in the mixed state as a function of magnetic field and temperature, and its variation near H_{c2} was compared with Maki's theory. (auth)

37395 USE OF COHERENT STATES IN THE THEORY OF SUPERFLUIDITY. Lopez, A. (Centro Atomico Bariloche, Argentina). Phys. Lett., 25A: 83-4(July 31, 1967).

It is shown how the matrix elements of the pseudo-unitary operator producing the Bogolyubov transformation for bosons and the corresponding states with sharp particle number, can be rather simply evaluated using eigenstates of the destruction operators. (auth)

37396 DAMPING OF OSCILLATIONS OF A TYPE TWO SUPERCONDUCTOR IN A MAGNETIC FIELD. Andronikashvili, E. L.; Ashimov, S. M.; Chigvinadze, D. G.; Tsakadze, J. S. (Inst. of Physics, Tbilisi, USSR). Phys. Lett., 25A: 85-6(July 31, 1967).

It is shown that the motion, with respect to the sample crystal lattice, of Abrikosov flux lines created in a type-II superconductor in the mixed state, causes the appearance of significant dissipative processes. (auth)

37397 EVIDENCE FOR AN ANOMALY IN THE THERMAL CONDUCTIVITY OF A MAGNETIC SYSTEM AT THE ORDERING TEMPERATURE. Huber, D. L. (Univ. of Wisconsin, Madison). Phys. Lett., 25A: 93-4(July 31, 1967).

Indirect evidence is presented for an anomalous increase in the thermal conductivity of magnetic systems in the vicinity of the ordering temperature. The evidence comes from studies of ultrasonic attenuation. (auth)

37398 MOTION OF IONS IN THE SATURATED FILM OF HELIUM II. Maraviglia, B. (Univ., Rome). Phys. Lett., 25A: 99-101(July 31, 1967).

In the course of a recent experiment it was suggested that an ionic current could exist in the saturated helium film. A set of measurements are described which have shown that: (1) ions can actually be injected in the helium film; (2) the dc characteristics in the helium film coincide with the ones in the bulk liquid; and (3) mobility measurements are easily made, limited by the determination of the true distance the ions travel. (W.D.M.)

37399 ORDER PARAMETER DEPENDENCE OF ULTRASONIC ATTENUATION IN THE MIXED STATE. Gottlieb, M.; Jones, C. K.; Garbuny, M. (Westinghouse Research Lab., Pittsburgh). Phys. Lett., 25A: 107-8(July 31, 1967).

Ultrasonic attenuation measurements at high magnetic fields in the mixed state were carried out for both clean and dirty limits, and compared with theory. (auth)

37400 ON THE EXISTENCE OF SEVERAL-QUANTA FLUX LINES IN TYPE II SUPERCONDUCTORS. Rocher, Y. A.; Renard, J. C. (Alcatel, Bruyeres-le-Chatel, France). Phys. Lett., 25A: 119-21(July 31, 1967).

The existence of several-quanta flux lines is shown to be possible in the surface vicinity of type-II superconductors. (auth)

37401 PITOT TUBE IN SUPERFLUID HELIUM. Craig, P. P. (Brookhaven National Lab., Upton, N. Y.). Phys. Lett., 25A: 79-80(July 31, 1967). (BNL-11409).

Recently Meservey has noted that operation of a pitot tube is inconsistent with irrotational flow. Experimental data obtained several years ago are presented showing that under some conditions both superfluid and normal fluid contribute to the Bernoulli pressure drop. (auth)

37402 EQUATIONS FOR TRANSITION PROCESSES IN SUPERCONDUCTING SOLENOIDS. Manuilov, V. G. Izv. Akad. Nauk SSSR, Energ. Transp., No. 3, 12-23(May-June 1967). (In Russian).

Processes related to the superconducting solenoid coil going normal were studied. In order to find an analytical solution for the integral-differential equation describing the transition process, a function $\beta(H)$ determining the rate of normal phase distribution was introduced as a function of magnetic field intensity in the transition region. Transitional characteristics were analyzed using solenoids prepared from various superconducting alloys. (tr-auth)

37403 SLIDING CONTACTS BETWEEN SUPERCONDUCTORS. Wong, N. F.; Farnell, G. W. (McGill Univ., Montreal). IEEE (Inst. Elec. Electron. Eng.), Trans. Instrum. Meas., IM-14: No. 3, 132-5(Sept. 1965).

The effect of relative motion on the contact resistance between certain superconductors was investigated. Results are presented for a variety of speed, pressure, and current conditions for lead-lead contacts of the slip-ring type in which one or both members are electroplated with a thin layer of normal metal. (auth)

37404 EFFECT OF METALLURGICAL VARIABLES ON SUPERCONDUCTING PROPERTIES. Livingston, J. D.; Schadler, H. W. (General Electric Co., Schenectady, N. Y.). Progr. Mater. Sci., 12: 183-287(1963-4).

Effects of metallurgical variables (solutes, dislocations, and precipitates) on superconducting properties are reviewed, with 474 references. In the past, any materials departing from the simple behavior of soft or type-I superconductors were called hard superconductors. The recent discovery of practical high-field superconductors has stimulated intensive study of hard behavior, and it is now realized that some of this behavior resulted from type-II superconductivity, some from a superconducting surface sheath, and some from specimen inhomogeneities. These concepts are considered, and the extensive prior literature in this field discussed in these terms. Most superconducting properties of a given phase can be divided into 3 types. These are referred to as primary, secondary, and tertiary properties, in order of increasing structure sensitivity. This classification is schematically represented, and each class of properties is discussed. (BBB)

37405 GENERATION OF HIGH MAGNETIC FIELDS. Parkinson, David H.; Mulhall, Brian E. (eds.). The International Cryogenics Monograph Series. Volume 5. New York, Plenum Press, 1967. 176p. $11.50.

The present technical situation with regard to generation of high magnetic fields (fields well in excess of 50 kOe) is summarized. Subjects discussed include applications of high fields, theoretical analysis of coil design, cooling of conventional solenoids, solenoid construction and instrumentation, power supplies, properties of hard superconductors, design and construction of superconducting solenoids, pulse techniques and flux concentration, and prospects for further progress. (A.G.W.)

37406 IMPROVEMENTS IN OR RELATING TO SUPERCONDUCTING COILS. Cornish, Donald Nelson (to United Kingdom Atomic Energy Authority). British Patent 1,081,058. Aug. 31, 1967. Filed Aug. 25, 1965.

A multilayer superconducting coil to be immersed in a cryogenic liquid is designed to allow free access of the liquid to the inner layers. A mesh interposed between adjacent layers has filaments of comparatively large diameter generally parallel to the axis of the coil interwoven with filaments of smaller diameter generally parallel to the turns of the windings. This arrangement offers a lower impedance to cryogenic liquid flowing generally parallel to the axis of the coil than to liquid flowing parallel to the turns of the windings. The mesh may be made of metal but a less abrasive material such as nylon or polyethylene terephthalate is preferred. (A.G.W.)

Plasma and Thermonuclear Physics

Refer also to abstract 37498.

37407 ISSLEDOVANIE PLAZMENNYKH SGUSTKOV. (Studies of Plasma Clusters). Sinel'nikov, K. D. (ed.). Fizika Plazmy i Problemy Upravlyaemogo Termoyadernogo Sinteza. (Plasma Physics and Problems of Controlled Thermonuclear Synthesis). Kiev, Naukova Dumka, 1967. 200p.

Twenty-one articles are grouped under three main sections: (1) plasma interactions with electromagnetic fields, (2) injection of plasma into various types of traps, and (3) diagnostics of plasma clusters. The first section is concerned with the effects of dissipative processes and gas kinetic pressures on the magnetic moment in the cluster, adiabatic motion of plasma clusters in longitudinal fields, and collision of clusters in axially symmetric fields. The second section includes the theory of electrodynamic plasma acceleration, propagation of current layers in a coaxial plasma gun, acceleration of plasma in coaxial sources, and structure of plasma clusters. The third section presents the methods of plasma diagnostics, active corpuscular plasma diagnostics, preparation of short plasma clusters, Thompson mass spectroscopic studies of plasma clusters, visual studies of plasma motion in curvilinear magnetic fields, and blackening of nuclear photoplates by various types and charge ions. (R.V.J.)

37408 VYSOKOCHASTOTNYE SVOISTVA PLAZMY. (High-Frequency Plasma Properties). Sinel,nikov, K. D. (ed.). Fizika Plazmy i Problemy Upravlyaemogo Termoyadernogo Sinteza.

(Plasma Physics and Problems of Controlled Thermonuclear Synthesis). Kiev, Naukova Dumka, 1967. 132p.

A collection of 13 articles present the results of the theoretical and experimental studies of the following: high-frequency plasma properties; method of high-frequency plasma heating; propagation of electromagnetic waves in magnetic plasma; plasma thermal emission; instabilities in high-frequency plasma heating; plasma heating by a fast magnetosonic high-amplitude wave; cyclotron resonance in a cold rotating plasma; quasi-linear plasma instability; and nonlinear theory of electromagnetic wave pulse passage through a plasma boundary. (R.V.J.)

Confinement and Heating of Plasma

37409 (IPP–1/63) UEBER DEN TOROIDALEN THETA-PINCH IN M + S-KONFIGURATION. (On the Toroidal Theta Pinch in M and S Configuration). Wolf, G. H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). June 1967. 110p. (In German). Dep.

The problems of a toroidal theta pinch in the M & S equilibrium configuration are discussed. Besides giving a brief survey of the toroidal theta pinch with a purely azimuthal magnetic field, the report discusses the results of theoretical and experimental investigations on the equilibrium and stability of M & S configurations. M & S experiments in a (closed) toroidal configuration were conducted with hydrogen plasmas of initially high β in the range of 10 eV, the corrugation of the plasma column being produced by means of additional current loops or shaped coils and vessels. The parameters of the vessel and discharge were: mean major torus radius 26 cm, mean minor radius of vessel 3 cm, maximum magnetic field 11 kG, half-cycle of main discharge 18 μs. The equilibrium surfaces calculated for $\beta = 1$ could be approximated closely. For several microseconds the plasma remained in the center region of the vessel. With shaped coils the reproducibility of the discharges was very good. The confinement time here was raised by a factor of about 3 to 4 compared with a similar theta pinch in a purely azimuthal magnetic field. The initial M & S-like corrugation of the plasma column smoothed out within a few microseconds. This can be explained (because of fast resistive diffusion) by the decrease of β with time. At the same time a gradual drift and in some cases a fanning out of the plasma column was observed. Both processes caused the plasma to come into contact with the wall. The parameters of the M & S plasma under discussion were not such that a stabilizing influence of the gyroradii could be expected; the results of these experiments confirm the equilibrium and stability studies in the MHD approximation. In a provisional LIMPUS experiment with a coil 1.5-m long supplied by the Isar I capacitor bank (in this case with $B_{max} = 110$ kG), no flute instabilities ($m \geq 2$) were observed at a filling pressure of 10 μ deuterium. Compared with the case of a noncorrugated linear theta pinch, no difference in the "wobbling" was found that would have indicated (additional) $m = 1$ instabilities. For $T_i \approx 4$ keV the time available for observing the plasma was 10 μs, while the calculated growth times of the MHD instabilities were below 1 μs. If the possible influence of the open ends (the middle section of the 1.5 m long coil being affected after 2 to 5 s) is disregarded, the results of this LIMPUS experiment suggest confirmation of the expected stabilization by the gyroradii. Further LIMPUS experiments (with extended coils as well) are being prepared to define the limits of the stable region and, in particular, to discover more about the $m = 1$ instability. A discussion is presented of aspects of long-term confinement of toroidal theta pinch plasmas. (auth)

37410 (UCID–15194) ELECTROLYTIC TANK INVESTIGATION OF ASTRON GUN AND ACCELERATOR EQUIPOTENTIALS. Capelle, G. A. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 1, 1967. Contract W-7405-eng-48. 13p. Dep. CFSTI.

Equipotentials for three types of Astron accelerator guns were determined. A wedge-type electrolytic tank analog of Laplace's equation was operated as two arms of a square-wave-powered, Wagner-grounded bridge in which the null detector was a high-gain oscilloscope. The analog system is described, and resulting equipotential plots are exhibited. (auth)

37411 ION HEATING IN A TURBULENT PLASMA. Hamberger, S. M.; Malein, A.; Adlam, J. H.; Friedman, M. (United Kingdom Atomic Energy Authority, Berkshire, Eng.). Phys. Rev. Lett., 19: 350-2(Aug. 14, 1967).

Evidence for the noncollisional heating of ions to energies up to 3 keV in a situation in which the heating must be due to fluctuation frequencies much greater than the ion cyclotron frequency is reported. The evidence is believed to result from statistical accelerations in the microfields of the turbulent spectrum of longitudinal plasma waves. (M.O.W.)

37412 TRANSFER PHENOMENA IN A RAREFIED PLASMA IN TOROIDAL MAGNETIC TRAPS. Galeev, A. A.; Sagdeev, R. Z. (Inst. of Nuclear Physics, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz., 53: 348-59(July 1967). (In Russian).

Transfer phenomena in a rarefied plasma related to toroidal particle drift are investigated. It is shown that the existence of so-called "trapped" particles results in a sharp increase of the transfer coefficients approximately by a factor $(R/r)^{\frac{1}{2}}$, where R and r are, respectively, the large and small torus radii. (auth)

37413 INVESTIGATION OF PLASMA HEATING UNDER CONDITIONS OF BEAM INSTABILITY IN A LINEAR DISCHARGE. Babichev, A. P.; Karchevskii, A. I.; Muromkin, Yu. A.; Buryak, E. M. Zh. Eksp. Teor. Fiz., 53: 3-15(July 1967). (In Russian).

Heating of a plasma produced by passing a longitudinal current through a magnetic mirror trap (mirror ratio 2) was investigated. The quasi-stationary magnetic field in the middle part of the trap changed from 250 to 2000 Oe. It is shown that in the initial pre-breakdown stage of the discharge, beam heating of the plasma occurs; this results in the appearance of hot electrons with a temperature ~50 keV and density $\sim 4 \times 10^{10}$ cm^{-3} in the cold plasma ($n_e \approx 2 \times 10^{12}$ cm^{-3}). The confinement time of the plasma with hot electrons in the magnetic trap was anomalously small (50 to 70 μsec), and decay of the hot plasma does not occur in a monotonous manner. Thus oscillograms of the diamagnetic signal exhibit sharp kinks accompanied by x-ray flashes. The heating efficiency of the plasma depends on the configuration of the magnetic field: fast electron production increases when the discharge is excited in an inhomogeneous magnetic field. It is shown that a dense ($n > 2 \times 10^{14}$ cm^{-3}), relatively cold ($T_e + T_i < 10$ eV) plasma is formed when attempts are made to heat the plasma by excitation of a heavy-current oscillatory discharge ($J \approx 15$ kA, $f \approx 70$ kc/s). (auth)

37414 CLOSED MAGNETIC TRAPS WITH ZERO ROTATION TRANSFORM ANGLE. Shafranov, V. D. At. Energ. (USSR), 22: 356-61(May 1967). (In Russian).

By the analytical method of deflection from the magnetic axis, the toroid trap for plasmas with closed lines of force of the magnetic field (with zero rotation transform angle) was investigated. The curvature of the magnetic axis of such traps was of necessity analog simulated. The modulation of the axis curvature permits making neighboring lines of force very short that is equivalent to the creation of the minimum of mean magnetic field on the axis, which is necessary for plasma stabilization. The principal possibility of the creation of the minimum of the mean magnetic field in the trap, the magnetic axis of which seems horizontally curved, was shown. (tr-auth)

Diagnostics of Plasma

Refer also to abstract 36446.

37415 (AD–650857) INSTRUMENTATION DEVELOPMENT PROGRAM. Hines, R. H.; Crosswy, F. L. (Arnold Engineering Development Center, Arnold Air Force Station, Tenn.). Apr. 1967. Contract AF 40(600)-1200. 98p. (AEDC-TR-233). CFSTI.

The design and operational characteristics of an in-house-built 5-cm-dia Kaufman-type ion engine that was used to evaluate diagnostic methods is presented. The discharge of the ion engine was investigated and analyzed by employing various types of material probes. The emissive probe was used to determine the beam potential, the electron temperature, and the ion impingement current density. The double Langmuir probe was used to determine electron temperature and ion impingement current density for cross correlation between probes. The analytical and experimental results are compared and discussed. (auth) (TAB)

37416 (IPP–1/64) INTERFEROMETRISCHE MESSUNGEN AN ISAR I. (Interferometric Measurements at ISAR I). Heiss, A. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). June 1967. 21p. (In German). Dep.

At the megajoule theta pinch experiment ISAR I the electron density was measured by end-on observation using a differential interferometer. The space- and time-resolved electron density measurements show the compression and lateral displacement of the plasma. The total number of electrons and ions inside the coil and the loss rate ($\sim 4 \times 10^{23}$ sec^{-1}) are calculated. The observations show that the plasma stays longer within the coil if the stored bank energy is increased. In certain cases, superimposed on the ordinary drift motion to the collector, there is an oscillation of the plasma column (wobbling) in the plane perpendicular to the coil. Impurities enhance the plasma end losses. (auth)

37417 (IPP–3/55) UEBER DIE MESSBARKEIT DER PLASMADRIFTGESCHWINDIGKEIT UND DES LORENTZ-POLARISATIONSTERMS DURCH MIKROWELLEN-MIT-FUEHRUNGSEXPERIMENTE. (On the Measurability of Plasma Drift Velocity

and Lorentz Polarisation Term by Means of Microwave Dragging Experiments). Tutter, M. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). July 1967. 13p. (In German). Dep.

The possibility of measuring the drift velocity of a plasma by means of its dragging of electromagnetic waves is discussed. As the coefficient of drag is strongly dependent on the Lorentz polarization term of the internal electric field of the plasma, such measurements should answer the question whether this term has to be taken into consideration in the plasma dispersion or not. (auth)

37418 (N-67-19949) DIAGNOSTICS OF ACCELERATING PLASMA. Semiannual Progress Report, September 1, 1966-February 28, 1967. Lie, T. N.; Ali, A. W.; McLean, E. A.; Chang, C. C. (Catholic Univ. of America, Washington, D. C. Dept. of Space Science and Applied Physics). Feb. 18, 1967. 44p. (NASA-CR-82950; SAPR-2). CFSTI.

The radial electron density distributions, the electron temperatures, and the shapes of the current sheets produced in coaxial plasma accelerators of different radius ratio were determined using fast photography and spectroscopic techniques. Pronounced polarity effect in these accelerators was observed for most of the working gases. However, in the case of hydrogen the polarity dependent behavior is much less noticeable. Present experimental methods were extended to the discharge plasma produced in a parallel plate plasma accelerator in an attempt to gain better understanding on the current sheet behavior. Since some of the spectroscopic techniques used or to be used in the investigation depend on the assumption of local thermal equilibrium, the validity of LTE in the plasma under interest was studied and its theoretical result is given. (auth) (STAR)

37419 (NP-16711) DISENO DE UN OBTURADOR ELECTRO-OPTICO PARA INVESTIGACION EN FISICA DE PLASMAS. (Design of Electro-optical Shutter for High Speed Photography in Plasma Studies). Humberto Fonseca Araujo, Walter (Instituto Politecnico Nacional, Mexico City. Escuela Superior de Ingenieria Mecanica y Electrica). 1965. 101p. (In Spanish). Dep.

Thesis.

The principles of fast photography are outlined. The photographic methods used in the study of electric discharges across gases are summarized. An electro-optical shutter is then designed and constructed. The characteristics of the shutter are measured. The economics of the shutter are evaluated. Applications of the electro-optical shutter to uses other than plasma studies are proposed. (J.S.R.)

37420 RADIATION TEMPERATURE AND ENHANCED DIFFUSION IN A RADIO-FREQUENCY DISCHARGE. Harmon, G. S.; Lautzenhiser, T. V. (Univ. of Maine, Orono). J. Appl. Phys., 38: 3422-3(July 1967).

Measurements of the radiation temperature of a rf discharge in He as a function of magnetic fields were made. The operating frequency was 3.5 MHz and He pressure was ~0.6 torr. The radiometer used was one in which the radiation properties of the discharge and a standard are alternately compared using a microwave receiver and a synchronous detector. A typical plot of electron temperature versus magnetic field is shown. The relatively low values of the radiation temperature increased with field rather abruptly, then became more or less constant. It was observed that the input power to the plasma from the transmitter, and consequently the plasma loss, varied in the same way as the radiation temperature. (A.G.W.)

37421 INTERACTION BETWEEN A MAGNETIC FIELD AND A PLASMA FLOW BEHIND A SHOCK WAVE. Kuriki, Kyoichi (Tokyo Univ.). J. Appl. Phys., 38: 3185-90(July 1967).

A theoretical calculation is made from which the electrical conductivity or magnetic Reynolds number of a shock-produced plasma flow can be derived. The results of the analysis predict the effects of the transient magnetic field induced by the interaction between the applied magnetic field and the plasma flow behind a shock wave. The applied magnetic field considered is transversal to the flow. Its intensity is either steady in time and increasing linearly in the flow direction or spatially uniform but increasing linearly with time. If the applied field extends to infinity, the intensity of the induced magnetic field is proportional to the magnetic Reynolds number and to the intensity of the applied magnetic field. With the aid of the present analysis the magnetic Reynolds number can be determined by comparison of the measured field and the calculated magnetic field. This method is applicable even if the magnetic Reynolds number is greater than unity. The effects of the finiteness of the applied field are considered. (auth)

37422 AN ATTEMPT TO MEASURE THE TEMPERATURE OF A LASER-PRODUCED PLASMA USING NEUTRON-DETECTION TECHNIQUE. Sun, K. H.; Hicks, J. M.; Epstein, L. M.; Sucov, E. W. (Westinghouse Research Labs., Pittsburgh). J. Appl. Phys., 38: 3402-4(July 1967).

An assembly of thirteen 2-ft-long $^{10}BF_3$ neutron detector tubes was used in an attempt to measure the number of neutrons produced in a deuterium-tritium gas by a ruby laser. Several series of laser shots were made using gas at pressures between 1 and 2 atm. None resulted in the unequivocal detection of neutrons. (A.G.W.)

37423 SPECTROSCOPIC TEMPERATURE MEASUREMENTS IN A LOW-PRESSURE MAGNETICALLY CONFINED ARGON PLASMA. Shipp, J. I. (Univ. of Tennessee, Tullahoma, ARO, Inc., Arnold Air Force Station, Tenn.); Tidwell, E. D. J. Opt. Soc. Amer., 57: 1061-2(Aug. 1967).

The excitation temperature in the core of a magnetically confined low-pressure plasma was obtained by the relative-intensity method, using the latest available transition probabilities. The data appear to confirm the transition probability of the 3545 Å line which was thought to be incorrect. (M.O.W.)

37424 EFFECT OF ELECTRON-CESIUM ION RADIATIVE RECOMBINATION ON THE INTENSITY OF SPECTRAL LINES OF CESIUM. David, J. P.; Kaftandjian, V.; Millet, J.; Talin, B.; Jarry, G. (Faculte des Sciences, Marseille, France). J. Phys. (Paris), 28: 514-18(July 1967). (In French).

The time-dependent luminous intensity of various lines of the spectrum emitted by the positive column obtained from an electric discharge (during ~10 μs) in a low pressure cesium vapor is studied. The particular aspect of the curves obtained is explained as due to the influence of the radiative recombination process. A method is deduced for the measurement of the total radiative recombination coefficient. (auth)

37425 MICROWAVE MEASUREMENT OF THE ELECTRON DENSITY AND EFFECTIVE COLLISION FREQUENCY IN ARGON IONIZED BY A SHOCK WAVE. Krylov, V. V.; Tusnov, Yu. I. (Moscow State Univ.). Teplofiz. Vys. Temp., 5: 1-6(Jan.-Feb. 1967). (In Russian).

A shock tube combined with a microwave measuring line was used to measure the free-electron density and the effective collision frequency in a plasma behind the front of a shock wave in argon. Approximately 60 experiments were made at initial pressures 0.6, 1.9, and 3.2 mm Hg. The shock wave velocities ranged from 2.1 to 3.7 km/sec. The microwave frequency was 2,730 MHz and the propagation mode was H_{10}. Plots are presented of the reflection coefficient, the phase shift upon reflection of the electromagnetic waves from the ionized argon, of the real part of the dielectric constant, and of the density of the free electrons at various pressures. The number of free electrons and the collision frequency both increased with increasing pressure, but not to the same extent. (ATD)

37426 CHARACTERISTICS OF PLASMA RESONANCE PROBE AND RF IMPEDANCE PROBE IN A MAGNETIC FIELD. Dote, Toshihiko; Ichimiya, Torao (Inst. of Physical and Chemical Research, Saitama, Japan). J. Phys. Soc. Jap., 22: 1266-73(May 1967).

Frequency characteristics of the planar and spherical plasma resonance probes and of the rf impedance probe in a magnetic field were analyzed by considering the equivalent electrical circuit for the plasma and sheath. The dependence of the resonant frequencies on the strength of magnetic field were theoretically studied and some new resonant phenomena were predicted. Some experiments were performed with the resonance probe in a mercury plasma, which proved the validity of most of the theoretical predictions. Both kinds of probe are being used for the rocket observation of the ionosphere where the geomagnetic field cannot be neglected. The results obtained here may introduce a useful method of analysis of such observational data. (auth)

37427 DETECTION AND MEASUREMENT OF PRECURSOR IONIZATION IN AN ELECTROMAGNETIC SHOCK TUBE. MacVicar-Whelan, P. J.; Smy, P. R. (Univ. of British Columbia, Vancouver). Can. J. Phys., 45: 2343-8(July 1967).

Precursor ionization in an electromagnetic shock tube was detected with various devices and measured with a double probe. The electron densities calculated from the double-probe results are in agreement with measurements obtained by other workers with different techniques and the electron temperatures are in the range 1 to 10 eV. The responses of various detection devices are in agreement with these results. (auth)

37428 LOW-FREQUENCY IMPEDENCE OF POSITIVE-COLUMN PLASMAS. Davy, P. (Faculte des Sciences, Orsay,

France). Rev. Phys. Appl., Suppl. J. Phys., 2: 65-71(June 1967). (In French).

The theory of low-frequency impedance of positive-column plasmas is discussed. A small signal theory is derived using the macroscopic transport equation for plasma and including the variation of ionization and collision frequencies with electron temperature. The impedance frequency locus, in the complex plane, $Z = r + jx$ consists of three parts, each of these is interpreted from the basic processes of positive columns. Some examples are given of impedance locus, and an attempt is made to interpret previous results. (auth)

37429 CONDUCTIVITY OF A PLASMA IN A STEADY MAGNETIC FIELD. Pradhan, T.; Dasgupta, B. (Saha Inst. of Nuclear Physics, Calcutta). Phys. Rev., 160: 184-8(Aug. 5, 1967).

Expressions are derived for the complex conductivity tensor of a homogeneous classical plasma in an external uniform magnetic field, in terms of electric field correlations, using the Kubo theory of transport phenomena. The main aim is to bring out explicitly the magnetic field dependence of the conductivity tensor. Exact relations between the conductivity tensor in the presence of the magnetic field and the same tensor in the absence of the magnetic field have been obtained. (auth)

37430 A 90° LASER SCATTERING EXPERIMENT FOR MEASURING TEMPERATURE AND DENSITY OF THE IONS AND ELECTRONS IN A COLD DENSE THETA PINCH PLASMA. Roehr, H. (Institut fuer Plasmaphysik, Garching, Ger.). Phys. Lett., 25A: 167-8(July 31, 1967).

T_e, T_i and n were determined from the ion line in a 90° scattering experiment. The values of n were confirmed by measurements of the satellite peaks. (auth)

37431 COMPARISON BETWEEN rf PROBE AND LANGMUIR PROBE MEASUREMENTS. Peter, G. (Institut fuer Plasmaphysik, Garching, Ger.). Phys. Lett., 25A: 171-3(July 31, 1967).

A new rf probe method for determining electron density is described and compared with Langmuir probe measurements. (auth)

37432 SHIFT AND WIDTH OF ISOLATED ION LINES IN THE ADIABATIC LIMIT. Roberts, D. E.; Davis, J. (Imperial Coll. of Science and Tech., London). Phys. Lett., 25A: 175-6 (July 31, 1967).

Calculations of the shift and width of isolated ion lines in the adiabatic limit are reported. (auth)

37433 EXCITATION TEMPERATURES OF NITROGEN PLASMA CALCULATED FROM MULTIPLET INTENSITIES. Grenning, Daniel A. (McDonnell Corp., St. Louis). J. Opt. Soc. Amer., 57: 963-4(July 1967).

A method is described for determining the excitation temperature of certain ionized gases having large spin–orbit splitting of its spectral lines. In order to calculate the degeneracy factors, a scheme was used to describe the splitting based on evaluating the spin-orbit energy perturbation. The after-glow region of an arc jet running on N_2 was employed as the light source. The spectral distribution was determined by use of a Jarrell–Ash half–meter grating spectrometer, a photomultiplier, and a strip–chart recorder. (M.H.R.)

37434 INTERFEROMETRIC HOLOGRAPHIC INVESTIGATION OF THE PULSED-DISCHARGE PLASMA. Ashcheulov, Yu. V.; Dymnikov, A. D.; Ostrovskii, Yu. I.; Zaidel, A. N. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett., 25A: 61-2 (July 17, 1967).

Transverse axial interference holograms of a pulsed lamp discharge were obtained, for which purpose a Q-switched ruby laser with a high spatial and time coherence has been developed. (auth)

37435 STUDY OF SHOCK-PRODUCED PLASMAS BY A MICROWAVE REFLECTION PROBE. Funahashi, Akimasa; Takeda, Susumu (Nagoya Univ., Japan). Denki Gakkai Zasshi, 86: 1958-67(Nov. 1966). (In Japanese).

Shock wave plasmas produced by discharging a 16-μF capacitor which could be charged up to 15 kV were studied by a microwave reflection probe consisting of a waveguide, where the shock velocity was measured by the usual technique using a photomultiplier. Measurements were made at Mach nos. of 7 to 25 in Ar and air for pressures of 0.1 to 2.0 mm Hg. Electron densities from 10^{13} to 10^{16} cm^{-3} and collision frequencies from 10^9 to 10^{11} sec^{-1} of plasmas produced by shock waves reflected at the probe end were measured by a 3-cm wave reflection probe which was placed at the end of a T tube of 5.0 cm ID. An 8-mm wave probe was used to check the results obtained by the 3-cm wave probe. Good agreement between the measured electron densities by both probes indicated the reliability of the method. It was found that the measured electron densities lower than the ones theoretically calculated from the Rankine–Hugoniot and Saha equations at relatively low Mach no. approach each other with increasing Mach no. and pressures. For instance, the measured electron densities agreed fairly well with the theoretical values within experimental errors for pressures of 0.5 to 2.0 mm Hg, and Mach nos. higher than 20. The discrepancy between theory and experiment for lower Mach no. and/or pressures might be explained by a slow ionization which is caused by nonthermal equilibrium, when the thermal dissipation must be taken into account. The collision frequencies calculated from the measured densities and predicted electron temperatures agreed fairly well with the measured values except at low Mach no., implying that the measured electron temperatures of plasmas were close to the predicted ones. (BBB)

37436 DETERMINATION OF ELECTRON DRIFT VELOCITY IN A GASEOUS DISCHARGE FROM DOPPLER SHIFTS OF PLASMA WAVES. Kerzar, B.; Weissglas, P. (Royal Inst. of Tech., Stockholm). Electron. Lett., 1: 43-4(Apr. 1965).

Measurements of Doppler shifts of plasma waves in a low-pressure Hg vapor discharge were made to determine the electron drift velocity in the positive column. Two modes of wave propagation with drastically different radial-field variations were used. The first of these modes is the azimuthally symmetric surface wave of Trivelpiece and Gould, which, at high phase velocities, has fields which are constant across the plasma column. The frequency of this mode should be Doppler-shifted by an amount corresponding to the average electron drift velocity. The second one was the mode introduced by a finite electron temperature and corresponding to ordinary logitudinal plasma oscillations in an infinite medium. Doppler shift of the frequency of this mode should correspond to the electron drift velocity near the plasma surface. Measurements of the Doppler shift were carried out in a circular waveguide partially filled with plasma. The two measurements of the drift velocity agreed well with each other, as well as with the measurement which was expected to give a value of the drift velocity near the plasma surface. Within the accuracy of the present experiment, which is of the order of ±10%, it was therefore concluded that there is no radial variation of the electron drift velocity in the discharge. (BBB)

37437 MEASUREMENTS OF VISCOSITY AND THERMAL CONDUCTIVITY OF A PARTIALLY IONIZED ARGON PLASMA. Kanzawa, Atsushi; Kimura, Itsuro. Nippon Koku Gakkaishi, 14: 1-8(Nov. 1966). (In Japanese).

Measurements were made of the viscosity and thermal conductivity of a partially ionized argon plasma at atmospheric pressure using a plasma jet which was considered to be in thermal equilibrium. The knowledge of the decay of the temperature and axial velocity distributions in the plasma jet makes it possible to obtain the numerical value of the viscosity and thermal conductivity, using the equations of continuity, motion and energy. The influence of the ionization on the viscosity and thermal conductivity could be noticed in the results, and it was found that their values, when calculated by using the simple kinetic theory, can be used for a rough estimation below 14,000°K. (IAA)

37438 SPECTROSCOPIC GAS TEMPERATURE MEASUREMENT: PYROMETRY OF HOT GASES AND PLASMAS. Tourin, Richard H. Fuel and Energy Science Series. New York, American Elsevier Publishing Co., 1966. 149p. $10.75.

The spectroscopic methods of gas pyrometry employing optical radiation of wavelengths from about 2000 Å in the ultraviolet region to 25μ in the infrared are discussed. The principles of gas pyrometry, the instruments, and illustrative applications are given. (M.O.W.)

Kinetics of Plasma

37439 (AD-650828) NONEQUILIBRIUM STRUCTURE OF HYDROMAGNETIC GAS-IONIZING SHOCK FRONTS IN ARGON. Hoffert, Martin I. (Polytechnic Inst. of Brooklyn, N. Y. Dept. of Aerospace Engineering and Applied Mechanics). Feb. 1967. Contract Nonr-839(38). 63p. (PIBAL-1008). CFSTI.

A "low-temperature" collisionally ionizing shock with oblique magnetic field is studied to determine whether certain concepts which exist in the current literature are relevant. Nondimensionalized equations governing the nonequilibrium structure of such a front propagating into un-ionized argon are formulated using ionization rates and an electron energy equation. Comparison of the magnitudes of viscous and magnetic Reynolds numbers within this front indicates that, if a structure exists, it must consist of a narrow "imbedded" viscous shock standing upstream of a much wider hydromagnetic interaction and ionization relaxation zone. Hence, a modified form of the Zeldovich–von Neumann–Doring (ZND) approximation is applicable to the structure problem. It is shown that in this approximation nontrivial steady-state structures cannot be constructed for "fast" gas-ionizing shocks. On the other hand, solutions are possible for "slow" waves. (auth) (TAB)

37440 (AD-650579) RESEARCH ON THEORY OF MAGNETO-GASDYNAMICS. Final Scientific Report. Denisse, J. F. (Observatoire de Paris-Meudon (France)). Dec. 15, 1965. Contract AF 61(052)-432. 113p. (AFCRL-66-527). CFSTI.

The report includes: study of waves in plasma submitted to a general adiabatic condition with no restriction on the pressure tensor; critical study of the linear approximation of the Vlasov equation and the Landau damping; and study of the Cherenkov radiation of a charge moving in a plasma, including frequency and angular spectra. (auth)(TAB)

37441 (AFCRL-67-0375) WAVE INTERACTION IN NON-RELATIVISTIC ELECTRON BEAM-PLASMA SYSTEMS. Scientific Report No. 17. Otteni, Gerald A. (Case Inst. of Tech., Cleveland, Ohio). July 1967. Contract AF19(628)-1699. 144p. CFSTI.

A theoretical model based on the linearization of the fluid equations and Maxwell's equations for wave interaction in a uniform plasma which is interpenetrated by a nonrelativistic electron beam is developed. The effects of electron-neutral and electron-ion collisions and temperatures of both the beam and plasma electrons are included and no quasi-static approximation is made for the electromagnetic field. An external dc magnetic field is assumed to act so that a general formulation is developed which is valid in the limit of small dc magnetic fields and in the limit as the field becomes very large. Graphs of the computer solutions are given for the propagation constants in a beam-plasma system for the cases of an unbounded system and for the TM wave solutions that may exist in an axisymmetric cylindrical system in which the finite beam interpenetrates an unbounded plasma. (auth)

37442 (ARL-67-0007) INTERACTION OF A HIGH CURRENT ELECTRICAL DISCHARGE WITH ITS SELF-INDUCED MAGNETIC FIELD IN THE PRESENCE OF GAS FLOW. Final Technical Report, June 30, 1964-June 30, 1966. Malliaris, A. C. (Avco Corp., Wilmington, Mass. Avco Missile, Space, and Electronics Group). Jan. 1967. Contract AF 33(657)-11310. 196p. (AVMSD-0085-67-RR). CFSTI.

An electrical discharge is considered between two electrodes arranged axisymmetrically. Discharge currents are used up to 2500 amperes in a steady state and in the presence of a nitrogen flow rate of the order of a few hundred milligrams per second. While an externally applied magnetic field is used only in cases of special interest, most of the work reported here is confined to the interaction of the discharge with its self-induced magnetic field and the main objective is to determine quantitatively the importance of magnetoplasmadynamic effects in the acceleration of plasma. After a brief consideration of the analytical background, several experiments are discussed and the corresponding results are analyzed. It has been determined that the self-induced magnetic field makes a substantial contribution, as high as 60% or higher in certain cases, to the acceleration of plasma. The particularly effective mechanism in these experiments seems to be the self-induced compression in the discharge which is also manifested as a cathode tip overpressure. It has been determined that the overpressure in question depends strongly on the discharge current, but is drastically reduced in the presence of an externally applied magnetic field. An interesting by-product of pressure measurements at the cathode tip is the determination of the cathode spot radius which has been found in the near vicinity of 5 mm with a small but detectable dependence on both the current and the pressure. Further experiments and experimental results are also presented from measurements of the impact pressure, the plasma velocity, and electric current density in the plasma flow. (auth)

37443 (ARL-67-0060) DETERMINATION OF DEPARTURES FROM LOCAL THERMODYNAMIC EQUILIBRIUM IN ARC PLASMAS. Olsen, H. N.; Bedjai, G.; Martindill, R. E. (Plasma Sciences Labs., Inc., Van Nuys, Calif.). Mar. 1967. Contract AF33(615)-5149. 88p. CFSTI.

The concept of local thermodynamic equilibrium has been investigated both theoretically and experimentally. Equilibrium characteristic curves have been constructed from absolute spectral intensities of the several species of radiation emitted by the free-burning argon arc plasma. Measurements were made over the pressure range $0.1 \leq P \leq 1.1$ atm. Complete local thermal equilibrium, in the sense that electrons and heavy particles have the same temperature, has been observed for pressures above 0.3 atm. Transition probabilities measured in the course of this investigation have been compared with those available in the literature. This comparison shows disagreement among investigators regarding the state of equilibrium existing even in the 1 atm plasma. (auth)

37444 (IRP-31/67) ROTATING MAGNETIC FIELD PINCH. Jones, I. R.; Lietti, A.; Peiry, J-M. (Laboratoire de Recherches sur la Physique des Plasmas, Lausanne (Switzerland)). July 1967. 31p. Dep.

Helium gas at a pressure of 60 mtorr is contained in a discharge tube of diameter 4.8 cm and length 49 cm which is equipped with end electrodes and is situated within a multi-turn solenoid. The gas is preionized by means of an axial current pulse of 9.5 kamps amplitude and 32 μsec duration. Following the preionization pulse, two high-power rf generators, each capable of delivering pulses of 7 periods at a frequency of 3.10 Mc, are triggered. One generator produces an oscillating axial current in the preionized plasma while the other induces an oscillating azimuthal current. The generators are adjusted to give equal B_θ and B_z peak amplitudes at the inner wall of the discharge tube. When the two oscillating currents are dephased by 90°, the plasma experiences the continuous magnetic pressure exerted by a rotating field. Streak photographs show that the plasma separates from the tube wall and implodes towards the axis. Framing pictures show that cylindrical symmetry is maintained during this implosion. The implosion stage of the pinch is shown to be well represented by a solution of the appropriate snow plow equation. At 1.1 μsec after the initiation of the rf discharge, luminosity again appears in the region of the tube wall and stays there for the remainder of the discharge. It is surmised that this light appears because the current sheath which is driving the pinch returns to the wall and subsequently flows there for the remainder of the discharge. Measurements made of the time variation of the inductance of the pinch support this supposition. (auth)

37445 (JINR-P9-3373-2) NELINEINOE VZAIMODEISTVIE LENGMYUROVSKIKH VOLN I ION-IONNYE SOUDARENIYA V TURBULENTNOI PLAZME. (The Non-Linear Langmuir Wave Interaction and Ion-Ion Collisions in Turbulent Plasma). Makhan'kov, V. G.; Tsytovich, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 21p. (In Russian). Dep.

The influence of the ion-ion collisions on the nonlinear effects of the Langmuir wave interaction in turbulent plasma has been investigated. It is shown that there exists a wide range of parameters, electron and ion temperatures, and plasma density at which only ion-ion collisions influence the nonlinear Langmuir wave interaction. The account of the ion-ion collisions can increase appreciably the intensity of the spectral transformation. Hence the account of ion-ion collisions is a matter of principle for the estimation of the nonlinear interaction efficiency. (auth)

37446 (JINR-P9-3394-2) KULONOVSKIE SOUDARENIYA CHASTITS V TURBULENTNOI PLAZME. (Coulomb Collisions in Turbulent Plasma). Makhan'kov, V. G.; Tsytovich, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 25p. (In Russian). Dep.

The effect of the Coulomb collisions on the intensity and direction of a spectral transformation in turbulent plasma is considered. A compound kinetic-hydrodynamic approach is developed which allows investigation of cases when virtual (difference) waves, appearing to nonlinear scattering, are in the region of frequent collisions. It is shown that, in this case, the Coulomb collisions essentially affect the intensity as well as the direction of a spectral transformation. (tr-auth)

37447 (N-67-18008) TURBULENCE BY ELECTROSTATIC FLUCTUATIONS. Tchen, C. M. (National Bureau of Standards, Washington, D. C.). Nov. 1, 1966. 22p. (NASA-CR-81719; NBS-9435). CFSTI.

The spectra of turbulence and density fluctuations in a plasma are derived from a hydrodynamic description. The turbulent spectrum is governed by a turbulent cascade process, a viscous dissipation, and a diffusion by electrostatic fluctuations. The density spectrum is governed by a density cascade process and a dissipation by collisions. The strong and weak interactions between waves are considered in the two cascade processes. The integral equations for the spectral functions are solved for the following three subranges: inertial convection subrange, viscous diffusive subrange, and inertial-diffusive subrange. (auth)(STAR)

37448 (NASA-CR-868) PLASMA BOUNDARY INTERACTIONS. Aisenberg, S.; Hu, P.; Rohatgi, V.; Ziering, S. (Space Sciences, Inc., Waltham, Mass.). Aug. 1967. Contract NASw-1014. 85p. CFSTI.

The interactions between moving plasmas and boundaries are studied theoretically and experimentally. The momentum and energy transport in the sheath is derived theoretically in terms of kinetic and moment equations. A new set of kinetic equations has been derived in order to allow for the microscopic incorporation of ionization phenomena. The tangential drag of the plasma on the cathode and the anode is studied experimentally and it is shown that the electrode drag is appreciable. The cathode drag is larger than the anode drag because of the positive ion current to the cath-

ode. From the drag measurement it is possible to determine the ion current partitioning to the cathode. A theory of ion microfield emission is developed to explain the electron current emission from the cathode since the thermionic emission or field emission alone cannot account for the electron emission. The phenomena of arc retrograde motion are briefly studied and are explained in terms of a plasma phase propagation in the direction of increasing magnetic field where the ambipolar diffusion loss is reduced. The energy transport mechanisms to the electrode are analyzed to determine the dominant ones. An improved insulation structure for arc electrodes has been devised and used to increase electrode life. The problem of arc constriction is studied and it is shown that the construction can be explained in terms of the balance between the input energy and the various energy loss modes. Experimental data are provided to confirm the theoretical dependence of arc diameter upon arc current, arc velocity, transverse magnetic field and upon reduced pressure. (auth)

37449 (NP-16891) PROPAGATION OF LARGE AMPLITUDE ALFVEN WAVES. Cross, R. C.; Watson-Munro, C. N. (Sydney Univ. (Australia). School of Physics). Apr. 1967. 4p. (ER-24). Dep.

The propagation of torsional hydromagnetic or Alfven waves in laboratory plasmas was studied for the case when the wave magnetic field b_θ is not small compared with the steady field B_θ. The results for perturbation ratios of b_θ to B_θ up to 2.7 are reported. (M.O.W.)

37450 (NP-16893) COMPRESSIONAL AND TORSIONAL WAVE MEASUREMENTS IN A DECAYING HYDROGEN PLASMA. Cross, R. C.; Lehane, J. A. (Sydney Univ. (Australia). School of Physics). Apr. 1967. 4p. (ER-26). Dep.

The propagation of both torsional and compressional waves in the same plasma is described. Measurements of velocity and attenuation were made for several times throughout the life of a decaying plasma. The results show the change in the characteristics of the plasma as it decays, the effect of ion-neutral coupling on the wave propagation, and give some indication of the effect of the radial density distribution on the wave propagation. The measurements were made using the SUPPER II machine. (M.O.W.)

37451 (NP-16908) BIBLIOGRAPHY ON THE HIGH-TEMPERATURE CHEMISTRY AND PHYSICS OF GASES AND PLASMAS. No. 23. Brewer, L. (comp.) (California Univ., Berkeley. International Union of Pure and Applied Chemistry. Commission on High Temperatures and Refractories). June 30, 1967. 31p.

The bibliography contains a listing of 168 articles. (M.O.W.)

37452 (NP-16955) EXPERIMENTAL INVESTIGATION OF MICROWAVE PROPAGATION IN A PLASMA WAVEGUIDE. Carlile, R. N. (California Univ., Berkeley. Electronics Research Lab.). Aug. 12, 1963. 104p. (TM-30).

The phase characteristics of a backward-wave pass-band mode have been measured in a circular waveguide which is coaxial with a circular isotropic plasma column. This mode has been identified as an n = 1 surface wave similar to that described by Trivelpiece. Zero-temperature plasma waveguide theory, which predicts this mode quite accurately, shows that a simple relation exists between the lower cutoff frequency and the electron plasma frequency. It is demonstrated that the plasma frequency obtained from this relation, where the cutoff frequency is determined from a measurement of the phase characteristics, agrees well with an independent measurement of the plasma frequency using the well-known cavity perturbation method. Noise measurements on the n = 1 and the symmetric n = 0 modes indicate that the signal-to-noise ratio is independent of input signal power and is about 7 db for the n = 1 mode and varies from about 7 to greater than 30 db for the n = 0 mode. A simple model of the plasma is proposed which explains all the noise observations reported here. It is pointed out that Crawford and Lawson independently propose a similar model. A strong dc axial magnetic field was applied to the plasma and the phase characteristics of the perturbed TE_{11} empty waveguide mode were measured and are presented. In this case, the two degenerate circularly polarized modes which constitute the TE_{11} mode in an empty waveguide become nondegenerate and thus will have different phase characteristics. The results are in qualitative agreement with the theoretical work of Bevc and Everhart. It is demonstrated experimentally that as the magnetic field is reduced, at a given frequency, the propagation constants of the two modes approach each other and finally coincide at zero magnetic field. (auth)

37453 (RM-5356-PR) PHYSICAL MODEL OF CYCLOTRON DAMPING. Lutomirski, R. F. (RAND Corp., Santa Monica, Calif.). May 1967. Contract F44620-67-C-0045. 15p. CFSTI.

A method for calculating the damping or growth rate of an electromagnetic wave of small amplitude propagating parallel to an external magnetic field in a fully ionized, collisionless plasma is given. Cyclotron damping or growth is shown to be governed by the energy exchange between the wave and those particles that feel the wave Doppler-shifted in frequency to their own cyclotron frequency. The rate of change of energy of a representative particle is computed and averaged over the initial velocity distribution to yield the mean power gained/lost by the particles due to the onset of the wave. Equating the power gained by the resonant particles to the rate of decrease in the electromagnetic energy of the field and of the oscillation energy of the remaining particles in the plasma yields the conventional damping rate for the waves. Compared with the more formal procedure of solving the coupled Vlasov and Maxwell equations, this method yields insight into the physical processes involved, avoids mathematical complications, and gives the time it takes for the asymptotic value to become valid. This is roughly the time required for electrons with the thermal velocity to drift more than one wavelength. (auth)

37454 (SU-IPR-141) STUDIES OF BEAM-PLASMA INTERACTION WITH TRANSVERSE MODULATION. Mills, D. M.; Abraham, E. E.; Crawford, F. W. (Stanford Univ., Calif. Inst. for Plasma Research). Mar. 1967. Contract AT(04-3)-326. 41p. Dep. CFSTI.

Experimental observations are described of electron beam/plasma interaction in low-pressure mercury-vapor discharges. Comprehensive data have been obtained of rf growth, phase velocity, axial and radial electric field profiles in the interaction region, and Faraday rotation, for the case of transverse modulation, i.e., for growth in the first azimuthally varying mode (m = 1). The work complements previous parallel studies of the axisymmetric mode (m = 0) made with axial modulation. The results are compared with cold and warm plasma theories of the interaction. It is concluded that the warm plasma theory gives a satisfactory approximation to the experimental results, and that the remaining discrepancies are due to lack of sharpness of the experimental beam edge. (auth)

37455 (UCRL-17564) PROPAGATION CHARACTERISTICS OF A HOLLOW PLASMA WAVEGUIDE. Katz, Joseph E. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1967. Contract W-7405-eng-48. 56p. Dep. CFSTI.

Thesis.

The dispersion relation for the axial propagation of electromagnetic energy in a hollow plasma waveguide is derived. The structure considered has a cross section consisting of a central cylindrical vacuum region surrounded by a plasma shell contained within a metal outer conductor. Solutions of the dispersion relation are presented which show the variation in propagation characteristics attained by varying the plasma properties, the radial dimensions, or the external magnetic field. Losses in the plasma region and the effect of finite conductivity in the metal outer conductor are considered. Propagation characteristics of a hollow plasma waveguide resemble those of a metal circular waveguide for large axial magnetic fields, but as the axial magnetic field is reduced, the phase characteristic of the guide changes to that of a slow wave structure. The attenuation characteristic of the hollow plasma waveguide, for waves of a TM type, may be lower by several powers of ten than that of conventional metal waveguides. (auth)

37456 (UCRL-50166) QUANTUM MECHANICAL TREATMENT OF STATIC TRANSPORT PHENOMENA IN NON-DEGENERATE PLASMAS. Williams, Robert H. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 3, 1967. Contract W-7405-eng-48. 172p. Dep. CFSTI.

Thesis. Submitted to Univ. of California, Berkeley.

A convergent kinetic equation for a nondegenerate electron gas is derived from the quantum mechanical BBGKY hierarchy for the Wigner distribution functions. A technique due to Guernsey is generalized to quantum mechanics. When the two-particle interaction is split into a strong, short-range part plus a weak long-range part, a Boltzmann-like kinetic equation is obtained in which the cross section is a sum of three terms: an exact binary collision cross section for the short-range part of the interaction, plus a Born approximation cross section for the dynamically screened long-range part of the interaction, plus a cross correlation cross section evaluated in the Born approximation. In the cross correlation term, the effects of the long- and short-range parts of the interaction are mixed. When the limit $\hbar \to 0$ is taken the classical convergent kinetic equation of Guernsey is not obtained, since Guernsey did not consider the cross correlation terms. After the kinetic equation is generalized to a fully ionized plasma, the kinetic equations are solved using the Chapman-Enskog technique. General expressions are obtained for the static transport coefficients in terms of the Chapman-Cowling bracket expressions. Among the quantities evaluated are the transport cross sections for the short-range part of the interaction. These are evaluated

using a phase-shift analysis. Exchange effects are also considered. Since no ad hoc cutoffs are necessary using this convergent kinetic equation, the bracket expressions are accurate through first order in the plasma parameter. Both dominant (logarithmic) and subdominant (nonlogarithmic) contributions to the bracket expressions are given correctly for all nonrelativistic temperatures such that the plasma is both fully ionized and nondegenerate. (auth)

37457 COLLISION EFFECTS ON ELECTRON DRIFT MOTION. Niu, Keishiro (Osaka Univ.). J. Phys. Soc. Jap., 23: 608-10 (Sept. 1967).

Electron motion in a plasma subject to perpendicular electric and magnetic fields is examined by using the Boltzmann equation. The Fokker–Planck type expression for the Lorentz gas is employed for the collision term in the Boltzmann equation. The analysis is limited to an initial motion of electrons under the weak effect of collisions as well as the strong effect of the external electromagnetic field. Collisions between electrons and ions cause a decrease in the electron drift speed and induce electric current along the electric field. (auth)

37458 PARAMETRIC EXCITATION OF ION PLASMA OSCILLATIONS. Yoseli, Morihiro (Electrotechnical Lab., Tokyo). J. Phys. Soc. Jap., 23: 611-17(Sept. 1967).

Parametric excitations of ion plasma oscillations are investigated in mercury-vapour plasma. The ion plasma oscillation is excited by the pumping oscillation at $2f_{pi}$ and $2/3f_{pi}$, where f_{pi} is the ion plasma frequency. The simultaneous parametric excitation of the ion plasma oscillation and low-frequency oscillations, whose frequencies are given by $f_0 \pm f_{pi}$ where f_0 is the pumping frequency, is also studied experimentally. (auth)

37459 DENSITY DISTRIBUTION AND PARTICLE DIFFUSION IN AN ENERGETIC ARC IN A MAGNETIC FIELD. Miyoshi, Syoichi (Inst. of Physical and Chemical Research, Tokyo). J. Phys. Soc. Jap., 23: 618-25(Sept. 1967).

The effects of magnetic field and pressure on the radial distribution of plasma density are investigated experimentally for an energetic arc of 10^{14} cm^{-3} density and 2×10^{5}°K temperature in relation to the diffusion phenomena of plasma. Experiments are made in argon at pressures ranging from 3×10^{-2} to 3×10^{-5} torr and at approximately 1000 to 4000 gauss magnetic field strength. Classical and Bohm type diffusion coefficients were examined for two different states of plasma: one of low ionization (<35%) and the other nearly fully ionized (>98%). The experimental results show that the e-folding length of the exponentially varying density profile is inversely proportional to the magnetic field strength at 3×10^{-3} torr pressure and to the square root of the strength at 3×10^{-5} torr pressure. This suggests that some types of turbulence would be produced in the fully ionized plasma of an energetic arc. (auth)

37460 CONTROLLED LANDAU DAMPING OF ION–ACOUSTIC WAVES. Alexeff, I.; Jones, W. D.; Montgomery, D. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev. Lett., 19: 422-5(Aug. 21, 1967). (ORNL-P-2962).

Landau damping of ion–acoustic waves was produced without appreciably changing the electron temperature, the ion temperature, the wave velocity, or the wave frequency of the system. A trace of light ions was added to the plasma and the mean thermal velocity of the light ions is comparable to the ion-wave velocity. Landau damping is both predicted and observed. (M.O.W.)

37461 AUTOMODEL SOLUTION OF THE PROBLEM OF THE RECOMBINATIONAL DECAY OF PLASMA. Perel'man, T. L.; Anisimov, S. I. (Inst. of Heat and Mass Exchange, Minsk). Dokl. Akad. Nauk SSSR, 172: 817-19(1967). (In Russian).

The self-modeling solution of the recombinational plasma decay equation was examined in the infinite range for cases of plane and spheric symmetry. It was assumed that the initial distribution of the particles is limited, as the particles decrease sufficiently fast to the infinity condition of the equation. The equation describes the recombination in the plasma at low particle concentrations. As the original particle density distributions are usually self-modeling, the solution of the diffusion equation becomes self-modeling as $t \to \infty$. For the linear case, the solution depends on the total initial number of particles. The effect of diffusion was taken into account in the derivations. It was found that in the plane case all particles recombine at $t \to \infty$, as the ionization is "quenched." (TTT)

37462 NONLINEAR INTERACTION OF MAGNETOPLASMA WITH ELECTROMAGNETIC WAVES. Sakamoto, Yuichi. J. Phys. Soc. Jap., 22: 1511(June 1967).

Interaction between a weakly ionized magnetoplasma of He produced by high-frequency discharge and a 9-GHz microwave field up to several watts was investigated. Observations of transmitted power through the plasma, double-probe signals, and an intensity of emitted visible light were made at a gas pressure of several mm Hg. At powers higher than 100 mW, the interaction is nonlinear and the minimum points with respect to the magnetic field shift to the direction of lower field with increasing microwave power. Variations of the electron temperature, the ion density, and the emitted light intensity with the magnetic field indicate that an important part of the injected microwave energy is expended in inelastic collision processes rather than the heating of electrons. (A.G.W.)

37463 COHERENT DOMAINS IN SOME PARAMETER SPACES INHERENT IN A BEAM–PLASMA REGIME. Yamamoto, Takayoshi; Ohniwa, Kohji; Akimune, Hideo; Suita, Tokuo (Osaka Univ.). J. Phys. Soc. Jap., 22: 1495-1500(June 1967).

It has been confirmed experimentally that there exist both upper and lower limits of the beam density for the spatially growing wave resulting from the beam–plasma interaction to maintain its coherence. The upper limit has its origin in the breaking of the resonant wave due to nonlinear effects, and the lower limit is attributed to the incoherent beam wave. According to experimental results it becomes possible to partition the parameter spaces inherent in a beam–plasma regime by some bounding surfaces into two domains; one is a coherent domain where the resonant wave keeps its coherence, and the other is an incoherent one where the wave loses its coherence and hence the regime is considered to be turbulent. (auth)

37464 PROPAGATION OF HYDROMAGNETIC WAVES IN COLLISIONLESS PLASMA. II. KINETIC APPROACH. Tajiri, Masayoshi (Univ. of Osaka Prefecture). J. Phys. Soc. Jap., 22: 1482-94(June 1967).

The propagation of hydromagnetic waves of small amplitude in a collisionless plasma is considered on the basis of the Vlasov equation. It is found that there exist the Alfvén wave and the fast and the slow magnetoacoustic waves as well as the nonoscillating mode with a vanishing real part of the frequency. Under some conditions, the nonoscillating wave causes the mirror instability in the direction nearly perpendicular to a magnetic field. Numerical discussions are carried out in the phase velocity plane as well as in the Friedrichs diagram for each type of wave, and are compared with the corresponding results in the Chew, Goldberger, and Low approximation. (auth)

37465 NONLINEAR KINETICS OF PLASMA. I. NONLINEAR INTERACTION OF ELECTRON PLASMA OSCILLATION. Matsuura, Kenya; Kurasawa, Takashi (Electrotechnical Lab., Tokyo). J. Phys. Soc. Jap., 22: 1461-71(June 1967).

The Hamiltonian formalism for nonlinear kinetics of collisionless electron plasma is established. The method deriving the fundamental equations of the nonlinear kinetics is based on a quantum statistical perturbational treatment for the interaction Hamiltonians which describe the elementary processes of the nonlinear coupling of electron plasma oscillation. The interaction Hamiltonians are obtained by the Bohm–Pines theory in an approximation of long wave length. The lowest-order process of the nonlinear interactions derived by this theory is the coupling between two modes of the oscillation in the participation of the electron. The nonlinear characters of oscillation arising from this coupling are investigated under the Maxwellian momentum distribution of electrons. From the standpoint of our theory, some remarks for several previous works are made. (auth)

37466 PROPAGATION OF ALFVEN WAVES IN A NONHOMOGENEOUS PLASMA IN THE CASE OF THE HOMOGENEOUS MAGNETIC FIELD PARALLEL TO THE GRAVITATIONAL FIELD. Deutsch, R. V. (Polytechnic Inst., Iasi). Rev. Roum. Phys., 12: 433-6(1967). (In Rumanian).

The exact solution to the differential equation for small perturbations corresponding to Alfven waves propagating in nonhomogeneous plasma in a magnetic field is presented. (M.O.W.)

37467 PROPAGATION OF PLASMOIDS AT HIGH PRESSURES. Freiwald, David Allen; Cambel, Ali Bulent (Northwestern Univ., Evanston, Ill.). Rev. Sci. Instrum., 38: 1337-9(Sept. 1967).

Laboratory observations wherein plasmoids were operated at pressures higher than those previously reported are described. In particular, the performance of "Bostick buttons" in plasma interaction studies in regions where electromagnetic shock tubes are commonly employed was investigated. (L.B.S.)

37468 EVOLUTION EQUATIONS FOR THE COHERENCE FUNCTION IN A RELATIVISTIC PLASMA. Balescu, R.; Sergysels, R. (Univ. Libre, Brussels). Nuovo Cim. (10), 50B: 378-81(Aug. 11, 1967).

The theory of coherence is based upon the study of the space-time autocorrelation function of the microscopic electric field: $\Gamma(r_1, r_2, t_1, t_2) \equiv \Gamma(e_1, e_2) \equiv \langle e(r_1, t_1)e(r_2, t_2)\rangle$, where the brackets denote the ensemble average. In vacuo, the coherence function

obeys two wave equations: $(\partial^2/\partial r_1^2)\Gamma = (1/C^2)(\partial^2/\partial t_1^2)F$. Generalizations of the equations for the field interacting with matter have been given previously. However, it does not appear that any serious attempt has been made for treating this problem with the techniques of nonequilibrium statistical mechanics. This paper is a first step towards such a treatment. (W.D.M.)

37469 SOME STUDIES OF ELECTRON CYCLOTRON ECHOES FROM PLASMA. Harp, R. S.; Bruce, R. L.; Crawford, F. W. (Stanford Univ., Calif.). J. Appl. Phys., 38: 3385-94(July 1967).

A single-particle collision theory of the two- and three-pulse echo trains that are stimulated when a magnetoplasma is subjected to repeated pulses at the cyclotron frequency is described, and results of a series of experiments supporting the applicability of the theory are presented. A major prediction of the analysis that has been confirmed experimentally is that, when dissimilar pulses are applied, an arbitrary pulse shape can be stored and recalled. The possible applications of echo phenomena to the study of collision processes, and in memory devices, are discussed briefly. (auth)

37470 HIGH-FREQUENCY CONDUCTIVITY OF A PARTIALLY IONIZED PLASMA IN THE LONG-WAVELENGTH LIMIT. Joyce, Glenn R.; Willett, Joseph E. (Univ. of Missouri, Columbia). J. Appl. Phys., 38: 3373-84(July 1967).

The high-frequency conductivity of a partially ionized, homogeneous plasma near equilibrium is calculated. Interactions between charged particles are treated by BBGKY methods, and interactions between neutral and charged particles are treated by a Boltzmann collision integral. Solution of the second hierarchy equation is facilitated by a modification of an operator technique developed by Dupree. Numerical results in the limit of infinite ion mass are studied in terms of an effective charged-particle–charged-particle collision frequency found to depend on the neutral-particle density and the external-field frequency. (auth)

37471 NONLINEAR COUPLING IN A MAGNETIZED PLASMA. Sjolund, Anders (Royal Inst. of Tech., Stockholm); Stenflo, Lennart. Z. Phys., 204: 211-14(1967).

The coupling coefficients for the nonlinear interaction between three different waves in a magnetized plasma were calculated by means of coupled mode theory. (auth)

37472 RADIATION FROM A SPHERE IN COMPRESSIBLE PLASMA. Unz, H. (Univ. of Kansas, Lawrence). Appl. Sci. Res. (The Hague), 17: 340-54(1967).

The Hansen's vector wave functions have been modified so it could apply directly for the solution of general exterior boundary value problems in compressible plasma for a spherical geometry. The vector wave function L has been included to represent an acoustic wave and the three angular orthogonal functions have been defined using complex Fourier series in the azimuthal direction. Using this modified method of vector wave functions, the exterior spherical boundary value problem in compressible isotropic plasma has been solved. The boundary conditions prescribed over the surface of the sphere have been the tangential electric field (or the tangential magnetic field) and the radial component of the velocity vector (or the pressure). From those four basic boundary value problems the coefficients have been derived and several particular cases have been discussed. (auth)

37473 DISPERSION EQUATION OF A RADIATIVE PLASMA WITH A FINITE ELECTRICAL CONDUCTIVITY. Vasiu, Mircea (Babes-Bolyai Univ., Cluj). Stud. Cercet. Mat., 19: 635-43 (1967). (In Rumanian).

The dispersion equation of a finite, homogeneous, compressible, nonviscous radiative plasma with a finite electrical conductivity was obtained from its normal oscillations. The plasma was assumed to be subjected to the action of its own gravitational field and of an axially uniform magnetic field. Radiative and heat-conductivity processes were assumed to take place within the plasma. For the sake of simplicity, rotation of the medium and the electric displacement current originating within the plasma were neglected. The obtained dispersion equation generalizes the dispersion relation derived by G. Ferrero. It was found that the magnetogravitational instability criteria remain identical in the case of both, a perfectly opaque homogeneous radiative fluid with zero heat conductivity and finite electrical conductivity and a similar fluid with infinite electrical conductivity. The analyzed problem presents special interest for astrophysics and magnetohydrodynamics in general. (TTT)

37474 THEORETICAL AND EXPERIMENTAL CONTRIBUTIONS TO THE THEORY OF NEGATIVE GLOW. Franck, Guenter (Univ., Munich). Ann. Phys., 19: 323-43(1967). (In German). Thesis.

By means of a generation function determined by the discharge voltage U_E and the dependence of the reduced length of the cathode fall on U_E, $pd = f(U_E)$, a diffusion model of the negative glow (NGL) is evaluated for cylindrical geometry. The plasma efficiency δ of the NGL can be evaluated. It is only dependent on U_E and the reduced length of the NGL. If the length of the negative glow, L, is smaller than a critical value $(L/R - r_0) \leq 3$ (tube radius R, constriction radius r_0), δ strongly falls. By the diffusion model the transition point from NGL to the Faraday dark space and to the positive column can be fixed. An energy balance of the plasma electrons shows that their average energy depends on the starting energy of the plasma electrons after creation by the cathode fall electrons. The diffusion model is valid for H_2 discharges up to pressures $p \leq 0.1$ torr. Good agreement with theory is found for the plasma-density profile along the tube axis, for the absolute plasma density, the plasma efficiency δ and the electrical field along the axis. (auth)

37475 VISCOSITY OF PARTIALLY IONIZED HYDROGEN. Belov, V. A. (Scientific Research Inst. of High Temperatures, Moscow). Teplofiz. Vys. Temp., 5: 37-43(Jan.-Feb. 1967). (In Russian).

The viscosity of partially ionized hydrogen was calculated in the temperature range of 26,000 and 30,000°K and in the pressure range from 10^{-3} to 10 atm. The calculations are based on the results of many published papers, with account taken of the contribution due to charge exchange. The approximations made in the calculations are described and the accuracy of the calculation is estimated. The total error is assumed not to exceed 30 to 35%. The contributions of various factors to the error are estimated. Means of improving the calculations are discussed, but it is emphasized that there are no experimental data at present to check the validity of the estimates. (ATD)

37476 LEVEL POPULATIONS AND INELASTIC LOSSES IN A TWO-TEMPERATURE PLASMA. Dubner, V. M.; Komarovskaya, N. V. (Scientific Research Inst. of High Temperatures, Moscow). Teplofiz. Vys. Temp., 5: 20-4(Jan.-Feb. 1967). (In Russian).

A qualitative analysis is presented of the level population and the rate of energy loss of electrons by inelastic collisions with impurity molecules in a weakly ionized two-temperature plasma. The molecule concentration is assumed to be much smaller than that of the atoms or the electrons, so that collisions between molecules can be neglected. The molecule was assumed to have only two nondegenerate levels, transitions between which are determined by collisions between the molecule and the electrons or the atoms. It is shown that with increasing the electron density or with increasing distance between the levels, the inelastic loss decreases. With unlimited increase in the electron temperature, the inelastic losses exhibit saturation. A loss to excitation of rotational levels of linear symmetrical molecules in inert-gas plasmas is considered and it is shown that under certain conditions these losses can be described within the framework of the two-level model. Numerical estimates are obtained for the limits of applicability of the model under consideration in the case of an argon plasma with nitrogen impurity. (ATD)

37477 ELECTRODYNAMIC STRUCTURE OF A PLASMATRON JET. Morozov, M. G. (Inst. of Mechanics, Moscow). Teplofiz. Vys. Temp., 5: 106-13(Jan.-Feb. 1967). (In Russian).

In view of the increasing use of electric-arc heaters (plasmatrons) as sources of high-temperature gas jets, the author investigated the distribution of the voltage and the current in such a jet, produced by plasmatrons of different designs, rated up to 300 kW, and different geometrical configurations. The jet characteristics were measured by means of probes as the geometric parameters of the nozzle and the polarities of the electrodes were varied. The results showed that the plasmatron jet is an inhomogeneous and nonstationary formation, consisting of regions with low and high resistivity and with different potential distributions. The region of high conductivity, where appreciable current can flow, can extend as much as 15 nozzle diameters from the outlet orifice. The potential in such a jet can reach 75 volts. The jet characteristics fluctuate with a frequency which in first approximation coincides with that of the self oscillations of the voltage and current of the arc. Application of a transverse magnetic field did not affect strongly the distribution of the electric characteristic along the jet. It is concluded that the great variability of the plasmatron jet must be taken into account when such jets are used for hydrodynamic and gasdynamic research. (ATD)

37478 PARAMETRIC EXCITATION DUE TO DENSITY GRADIENT IN A PLASMA. Takeo, Akimasa (Tokyo Univ.). J. Phys. Soc. Jap., 22: 1282-3(May 1967).

The existence of a mechanism for parametric excitation in a plasma located in an oscillating electric field is shown. The parametric excitation recently predicted by Silin occurs owing

to coupling of motions of the electrons with those of the ions; if the motions of the ions are neglected, it cannot occur in uniform plasma. The type of parametric excitation pointed out is based on the gradient of the density. Motions of the electrons interact with themselves if a density gradient exists; thereby parametric excitation occurs even if motions of the ions are neglected. In actual plasmas the mechanism of excitation based on the density gradient prevails over that predicted by Silin, because the electron–ion mass ratio is very small. (auth)

37479 RESONANCE PHENOMENA IN A BOUNDED MAGNETOPLASMA. Kubo, Hiroshi (Kyoto Univ.). J. Phys. Soc. Jap., 22: 1274-81(May 1967).

Resonance phenomena are observed in transmission, reflection, and emission from a plasma column in a static magnetic field. The resonant waves lie in the frequency range $\omega_p < \omega < \omega_b$ and therefore they are not the same resonant waves as in the unbounded magnetoplasma. It can be shown on the basis of the dispersion relation, that these resonant phenomena are due to the formation of standing waves of the electromagnetic waves propagating obliquely to the static magnetic field in the bounded magnetoplasma. (auth)

37480 LANGMUIR PROBE CURRENT IN TURBULENT FLOW OF WEAKLY IONIZED GAS. Takeda, Koichi; Saito, Koichi; Hatta, Yoshisuke (Tohoku Univ., Sendai). J. Phys. Soc. Jap., 22: 1302(May 1967).

Correlations between the hydrodynamic turbulence and the fluctuation of Langmuir probe current were studied in a weakly ionized gas flow at high speed and low pressure. Plasma was produced by an rf discharge in a wind tunnel. Signals were recorded from a hot wire anemometer and a double probe spaced 4 mm apart and located in the center of the wind tunnel about 2.2 cm downstream from the plasma source. Fluctuations in the probe current were seen in the case of turbulent flow but not in laminar flow. The wave forms of the probe current fluctuations resembled those of the anemometer, but phase relations between the two waves were not steady. In some pressure regions the two fluctuations were in phase while in other regions they were in antiphase. (A.G.W.)

37481 ENHANCED MICROWAVE EMISSION FROM HIGHLY IONIZED PLASMA IRRADIATED BY MICROWAVES. Kubo, Hiroshi (Kyoto Univ.); Nakamura, Sadao; Mitani, Kenji; Otsuka, Masamoto. J. Phys. Soc. Jap., 22: 1304(May 1967).

Typical emission spectra are shown for a highly ionized plasma irradiated by an intense microwave polarized normally to a static magnetic field. A strongly enhanced peak is observed near the electron cyclotron frequency and at harmonics up to the third. The emission powers are especially large for the fundamental and the second harmonics, and they are higher by about 30 db than those of noise power in the absence of microwave irradiation. They increase with the irradiation microwave power. (A.G.W.)

37482 PLASMA-PRODUCED TIME DELAY OF REFLECTED PULSES. Roberts, C. A.; Fiskin, J. M. (Douglas Aircraft Co., Inc., Santa Monica, Calif.). J. Spacecraft Rockets, 4: 950-1 (July 1967).

A calculation of the transmit time delay for a collisionless inhomogeneous plasma was carried out by neglecting the effects of distortion. Limiting cases were derived. (M.O.W.)

37483 SELF-OSCILLATIONS OF CYLINDRICAL RESONATORS WITH MAGNETO-ACTIVE PLASMA. Yakimenko, I. P.; Kel'ner, T. R. (Kharkov State Univ.). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 815-24(1967). (In Russian).

The dispersion equation determining the self-oscillation spectrum of a cylindrical resonator partially filled with magnetoactive plasma is obtained by means of the boundary electrodynamic problem solution. The formulas are presented to calculate the high-frequency field distribution in the resonator. There have been made numerical calculations of the resonance frequencies, field distribution and quality factor for several important types of oscillations. (auth)

37484 HIGH-FREQUENCY WAVES IN A COLLISIONAL PLASMA WITH MAGNETIC FIELD. Buti, B. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 160: 188-94(Aug. 5, 1967).

The damping of electron-plasma oscillations, in a hot plasma in an external uniform magnetic field in the presence of weak Coulomb collisions, is investigated by using the Fokker–Planck equation. The electron–ion collisions play the dominant role; nevertheless, the electron–electron collisions become important as the wavelength decreases from infinity. As far as the electron–ion collision contribution is concerned, the frictional term exceeds the diffusion term; but in the electron–electron case, both the frictional and the diffusion contributions are of the same order. The two-body Coulomb collisions have a stabilizing effect on these plasma waves; the magnetic field, however, does not affect the longitudinal waves, but has a tendency to stabilize the left-handed polarized wave and to destabilize the right-handed polarized wave. (auth)

37485 MEASURED COLLISIONAL EXCITATION RATE COEFFICIENTS FOR OXYGEN VII. Elton, R. C.; Koeppendoerfer, W. W. (Naval Research Lab., Washington, D. C.). Phys. Rev., 160: 194-201(Aug. 5, 1967).

Rate coefficients of 3.1×10^{-11} cm^3 sec^{-1} and 1.5×10^{-11} cm^3 sec^{-1} for collisional excitation of the n = 2 singlet and triplet levels from the $1s^2\ ^1S_0$ ground state in helium-like O(VII) have been determined within a factor of 2 in a plasma at an electron temperature of kT = 250 ± 60 eV and density of $(6.2 \pm 1.5) \times 10^{16}$ cm^{-3}. The former compares favorably with a value of $(2.9 \pm 1.0) \times 10^{-11}$ cm^3 sec^{-1}, calculated near threshold with an effective Gaunt factor of 0.2 for the same temperature. These coefficients have resulted from measurements on a θ-pinch device of the absolute intensity of the $1s2s\ ^3S_1 - 1s2s\ ^3P_{0,1,2}$ lines at 1639.6, 1638.0, and 1623.3 Å, respectively, and from relative measurements of the ratio of intensities for the $1s^2\ ^1S_0 - 1s2p\ ^3P_1$ and $1s^2\ ^1S_0 - 1s2p\ ^1P_1$ spectral lines at 21.8 and 21.6 Å respectively. Rate coefficients for the 2S–2P singlet and triplet transitions and for the 1s2s $^3S_1 - 1s2s\ ^1S_0$ spin-exchange transitions have been calculated, as have the relevant transition probabilities. The measured oxygen concentration was (0.6 ± 0.2)% in a deuterium plasma at an initial pressure of 60 mtorr. Considerations of radiative transfer are invoked to explain measurements over a long axial path length of a low intensity for the singlet resonance line at 21.6 Å, compared to the intercombination line at 21.8 Å. (auth)

37486 INTERACTION OF A FLOWING PLASMA WITH A NONUNIFORM MAGNETIC FIELD. Fearn, D. G. (Imperial Coll. of Science and Tech., London). Phys. Lett., 25A: 168-9 (July 31, 1967).

An analysis of the retardation in a transverse magnetic field of the flowing plasma in an electromagnetic shock tube yielded conductivities much greater than estimated from shock theory. It was concluded that the plasma was discharge-heated. (auth)

37487 AVERAGE FRACTIONAL ENERGY LOSS λ DUE TO COLLISIONS WITH N_2 MOLECULES OF ELECTRONS IN A HIGH PRESSURE DISCHARGE PLASMA. Janca, J. (Purkyne Univ., Brno). Phys. Lett., 25A: 165-6(July 31, 1967).

The values of the average fractional energy loss λ due to collisions with N_2 molecules, of electrons with different electron temperature T_e were claculated. In a high-pressure discharge plasma the calculated values of λ are larger than those tabulated up to the present time. (auth)

37488 ONSET CHARACTERISTICS OF THE CONSTRICTED POSITIVE COLUMN AT MODERATE PRESSURES. Sugawara, M. (Univ. of Liverpool). Phys. Lett., 25A: 154-5(July 31, 1967).

Onset characteristics of the filamentary constricted positive column for Ne and Ar are described. According to measurements of gas temperature and electric field strength (E/P), it is inferred that cumulative ionization and diffusion loss are dominant processes. (auth)

37489 ELECTRIC FIELDS AHEAD OF IONIZING SHOCK WAVES. Watson-Munro, C. N. (Univ. of Sydney). Phys. Lett., 25A: 156-7(July 31, 1967).

Some experimental measurements of the electric field ahead of an ionizing shock front give strong support to the theoretical hypothesis of a number of workers. (auth)

37490 QUANTUM EFFECTS IN A SEMICLASSICAL PLASMA. Ljolje, K. (Univ. of Sarajevo, Yugoslavia); Sips, V. Phys. Lett., 25A: 159-60(July 31, 1967).

The influence of quantum effects on the high- and low-frequency solution of the dispersion relation in a semiclassical electron–ion plasma is investigated. (auth)

37491 WAVES IN HOT, ANISOTROPIC ELECTRON PLASMAS. Agdur, Bertil; Weissglas, Peter (Royal Inst. of Tech., Stockholm). Ericsson Tech., No. 2, 267-94(1964).

A general discussion is presented of wave propagation in hot magnetized plasmas, with special attention paid to waves that can propagate parallel to a static magnetic field on a plasma slab. The general behavior of and connection between surface waves, electroacoustic waves, whistler waves, and waveguide waves are discussed. The two kinds of modes that can exist for wave propagation parallel to a magnetic field in a hot infinite plasma are discussed: one with longitudinal electric field, the temperature mode, which is independent of the magnetic field and another with transverse fields which is independent of the temperature. The second type of modes has one slow branch and two fast branches. The first of these

branches contains whistler waves and waves at cyclotron resonance. The temperature mode intersects the transverse mode-type at three points. When the magnetic field is slightly inclined to the direction of wave propagation, the longitudinal and transverse fields will be coupled. As a result all intersections disappear and the fields change rapidly from longitudinal to transverse character in the region where the coupling occurs. When the plasma is bounded transverse to the direction of wave propagation both the whistler mode and the temperature mode are split into an infinite number of modes. In addition to these modes which can propagate in an infinite plasma, there will also exist surface charge modes in a bounded plasma. In an appendix the dispersion relation for waves on the plasma waveguide is derived. (BBB)

37492 STATISTICAL THEORY OF NON-EQUILIBRIUM PROCESSES IN A PLASMA. Klimontovich, Yu. L. Cambridge, Mass., Massachusetts Institute of Technology Press, 1967. 297p. $12.50.

Translated by H. S. H. Massey and O. M. Blunn.

The following sections are included: (1) Maxwell equations for slow and fast processes, (2) microscopic equations for a plasma, (3) equations with a self-consistent field — Vlasov equation, (4) correlation functions and spectral functions, (5) kinetic equations and expressions for spectral functions when the radiation by plasma waves is taken into account, and (6) hydrodynamic description processes in a plasma. (M.O.W.)

37493 VZAIMODEISTVIE ZARYAZHENNYKH CHASTITS S PLAZMOI. (Interaction of Charged Particles with Plasma). Sinel'nikov, K. D. (ed.). Fizika Plazmy i Problemy Upravlyaemogo Termoyadernogo Sinteza. (Plasma Physics and Problems of Controlled Thermonuclear Synthesis). Kiev, Naukova Dumka, 1967. 196p.

Nineteen separate articles are devoted to the following: plasma oscillation excitation by electron and ion beams; instabilities induced by beam interactions with plasma; wave propagation in waveguides; plasma acceleration; and gas discharge. (R.V.J.)

Production of Plasma

37494 (N-67-19934) COMPUTER PROGRAMS FOR THE CALCULATION OF EQUILIBRIUM STATES IN REFLECTED SHOCK PLASMAS. Koopman, David W. (Maryland Univ., College Park). Nov. 1966. 58p. (NASA-CR-82931; BN-481). CFSTI.

Procedures have been developed for the calculation of the states attained behind incident and reflected shocks in fully dissociating and partially ionizing gases initially composed of a mixture of molecular species. Ideal shock tube flow conditions are assumed; the calculations include the effects of temperature dependent partition functions, lowered ionization potentials, and simultaneous ionization of a number of atomic species in several ionization stages. The calculation has been programmed in the MAD computer language and applied to shocks in neon containing additives, with reflected region temperatures in the 8,000 to 14,000°K range. The theoretical background of the calculations, as well as the programs and results, are presented; programs for the calculation of equilibrium conditions, given pressure (or electron density) and temperature, are also presented. (auth) (STAR)

37495 (NP-16892) PROPAGATION OF HYDROMAGNETIC IONIZING FRONTS WITH LARGE DRIVING CURRENTS. Cross, R. C.; James, B. W.; Watson-Munro, C. N. (Sydney Univ. (Australia). School of Physics). Apr. 1967. 4p. (ER-25). Dep.

The production of highly ionized dense plasmas with hydromagnetic ionizing waves was investigated using the SUPER II machine. The steady axial magnetic field covered values up to 12 kG and the azimuthal drive magnetic field covered values up to 3 kG. (M.O.W.)

37496 (NYO-3578-6) PRODUCTION OF PLASMAS FOR THERMONUCLEAR RESEARCH BY LASER BEAM IRRADIATION OF SOLID PARTICLES. Annual Review, Semiannual Report, June 29, 1966–July 31, 1967. Haught, Alan F.; Polk, Donald H.; Fader, Walter J. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Contract AT(30-1)-3578. 125p. (UARL-F920365-6). Dep. CFSTI.

The major results obtained in the studies with laser-irradiated single-particle plasmas are summarized, and the apparatus developed for these studies is described. Two models of the formation and expansion of laser-irradiated solid-particle plasmas are discussed—the first, a hydrodynamic model which provides a detailed picture of the density, velocity, and temperature distributions within the plasma; the second, a simplified model which displays all of the major features of the plasma growth. The second model is used for calculations of the effects of different experimental parameters on the plasma energy and has been employed to determine the optimum conditions for maximum plasma energy in the experiments. Measurements of the free plasma expansion are discussed, including the magnitude and spherical symmetry of the plasma expansion velocity and density, comb-probe studies of the plasma flux distribution, measurements of recombination occurring in the plasma, and microwave interferometer studies of the plasma expansion. A theoretical treatment of the initial interaction of these plasma expanding into uniform magnetic fields, the geometry at the center of the mirror and minimum-B fields employed in the experiments, is presented. Experimental studies of the interaction of the laser-produced plasmas with containment magnetic fields of mirror, cusp, and minimum-B geometry at field strengths up to 8 kG are described. These studies include measurements of the plasma escape both along and across magnetic field lines, and microwave studies of the plasma density decay within the magnetic field. The results of the research program are outlined and, based on these results, areas for further investigation with these plasmas are presented. (auth)

37497 (WERL-3472-7) PLASMA PRODUCTION BY A HIGH-POWER Q-SWITCHED LASER. Quarterly Progress Report 2, May 1, 1967–July 31, 1967. Englehardt, A. G. (Westinghouse Research Labs., Pittsburgh, Pa.). Aug. 1, 1967. Contract AT(30-1)-3472. 5p. Dep. CFSTI.

During this period the laboratory enlargement was completed making possible the use of the ¾-meter spectrograph and the gigawatt laser in conjunction with the previously installed experimental system. Additional improvements made to the pedestal and tracking system provide long periods of trouble-free operation. As the result of the addition of the pedestal to the lowermost arm of the glass cross, the 70-GHz microwave interferometer has been modified and reinstalled. The absorption of the laser pulse is being studied using a two photodiode technique. The photon scattering experiment is in the final stages of assembly. Some theoretical calculations have been made on the heating and expansion of a spherical aluminum plasma. (M.O.W.)

37498 VACUUM GASDYNAMIC SETUP WITH ELECTRIC-ARC HEATING OF THE GAS. Rebrov, A. K.; Yarygin, V. N. (Inst. of Heat Power Engineering, Novosibirsk, USSR). Teplofiz. Vys. Temp., 5: 182-4(Jan.-Feb. 1967). (In Russian).

A vacuum gasdynamic setup aimed at investigating the operation of a plasmatron when the pressure in the latter ranges from atmospheric to the minimum possible one is described. Its main purpose is to produce a gas stream with uniform temperature field and velocity field, and without contamination due to the electrode erosion products. The apparatus consists of the plasmatron proper, a working chamber, a cooling chamber, and vacuum-producing equipment. Preliminary experiments were made to check the operation of the plasmatron supply system and the vacuum system, using argon as a gas, and showed an efficiency close to 50%. (ATD)

37499 RAISING OF PRECISION IN CURRENT RECORDINGS INVESTIGATING MAGNETOPLASMIC GENERATORS. Yakovlev, V. A. Magnit. Gidrodin., No. 4, 153-4(1966). (In Russian).

In recording current and voltage distributions in a magnetoplasma generator (MPG), oscillations due to arc inhomogeneities of the plasmatron, which attain a value of 30% of the useful signal, are superimposed on the main current. A constant-current amplifier which gives an output signal of 20 mA is proposed as a correction device. A circuit diagram of the amplifier is given. A comparison of oscillograms of a current with and without the correcting device shows insignificant improvement in the recording accuracy with the use of the recording device. (TTT)

37500 PLASMA PRODUCTION BY LASER BEAM IRRADIATION OF A SINGLE SOLID PARTICLE. DeMichelis, C.; Ramsden, S. A. (National Research Council, Ottawa). Phys. Lett., 25A: 162-3(July 31, 1967).

A study has been made of the plasma produced by focusing a Q-spoiled ruby laser beam onto a single particle of lithium hydride suspended in a vacuum. Streak photographs have been taken and the electron temperature measured from the soft x-ray emission. (auth)

Stability of Plasma

37501 (EUR-2530.f) ETUDE DU FONCTIONNEMENT D'UN CHALUMEAU A PLASMA. (Study of the Operation of a Flute Plasma). Marchandise, H.; Looman, B. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1965. 121p. (In French).

The operational characteristics of a flute plasma were studied in a detailed fashion. In the study of the electrical characteristics and of the thermal yield, the effects of the principal variables, which determine the operation of this device, were examined. These variables were the current intensity, and gas flow, the na-

ture of the gas, and the electrode spacing. The results showed a basic relation between the yield of the flute and the voltage at the boundaries. For the same gas and the same anode, the yield is a function of the voltage, regardless of the variations of the current, gas flow, and electrode spacing. The quantity of heat in the plasma jet was determined by means of a specially designed calorimeter. With argon the yield of the flute at a power of 20 kW is 55 to 60%. The functioning with injection of nitrogen at a power of 40 kW gives a yield which, according to the anode used, can vary between 60 and 80%. (tr-auth)

37502 (MPI-PAE/PL-3/67) EFFECTS OF MAGNETIC SHEAR ON DENSITY GRADIENT DRIFT INSTABILITIES. Kitao, Kazuo (Max-Planck-Institut fuer Physik und Astrophysik, Munich (West Germany)). Apr. 1967. 30p. Dep.

The amounts of magnetic shear necessary to stabilize density gradient drift instabilities are estimated for a plasma with $1 \gg \beta > m/M$ where β = plasma pressure/magnetic pressure, m and M are the electron and ion masses. The stability criteria for electrostatic convective modes are shown to be slightly modified from those obtained previously for $\beta < m/M$. For $\beta > m/M$ however, one must also consider unstable Alfvén type modes. It is shown that the critical amount of magnetic shear is proportional to β^{-1} for the convective Alfvén type modes and to $\sqrt{\beta}$ for the nonconvective modes. (auth)

37503 (TID-23947) A STUDY OF THE INTERCHANGE INSTABILITY IN ELECTRON CYCLOTRON HEATED PLASMAS. Christy, Edmund Harris Jr. (Tulane Univ., New Orleans). Aug. 3, 1966. 100p. Dep. CFSTI.

Thesis.

A series of experiments have been performed on a hot electron plasma produced in a magnetic mirror configuration by electron cyclotron resonance heating. Using the Physics Test Facility of the Oak Ridge National Laboratory, the flute instability has been observed and measurements of the phase velocity of the wave made. The l = 2 mode was found dominant in this machine but higher-order flutes were also observed. The shorter-wavelength modes appear to be the first to grow and persist even when the longer wavelengths are damped. Measurements of the bremsstrahlung emission permit determination of the energetic electron distribution and density. The phase velocity of the flutes corresponds closely to the electron gradient B drift velocity. Interferometric measurements of the density of the cold plasma at the threshold of the instability show it to be approximately 5% as dense as the energetic component. This figure is compared to representative theoretical treatments and found to be in reasonable agreement with a simplified finite-length dielectric plasma model. (auth)

37504 LINEAR THEORY OF COLLISION-INDUCED INSTABILITY OF PARTIALLY IONIZED GASES IN EXTERNAL MAGNETIC FIELD. Suzuki, Kunihiro (Nagoya Univ., Japan). J. Phys. Soc. Jap., 22: 1454-60(June 1967). (IPPJ-50).

A linear theory of collision-induced instability of partially ionized gases is developed for waves propagating along an external magnetic field. Transverse waves are treated. The effect of finite wave numbers is fully taken into account. The electron collision frequency ν is assumed to depend strongly on the magnitude of electron velocity. A dispersion relation is obtained and solved numerically. Four high-frequency modes are obtained. The first three modes are identified with the waves in the cold plasma, namely, two electromagnetic modes and one Alfven mode. The fourth mode will not appear when the velocity dependence of the collision frequency $\nu(v)$ is not explicitly taken into account. When h > 3, the last mode is unstable for small k but it represents a damping wave for large k. (auth)

37505 NONLINEAR EVOLUTION OF A TWO-STREAM INSTABILITY. Roberts, K. V.; Berk, H. L. (Univ. of California, San Diego, La Jolla). Phys. Rev. Lett., 19: 297-300(Aug. 7, 1967).

Calculations of a two-stream instability have been made by following the motion of the phase-space boundaries of an incompressible and constant-density phase-space fluid. Because of the condensation of holes, which to a good approximation act as gravitational particles, large-scale nonlinear pulses develop. (auth)

37506 HELICAL INSTABILITY AND NONLINEAR EFFECTS OF SHORT MAGNETIZED POSITIVE COLUMNS. Yatsui, Kiyoshi; Inuishi, Yoshio (Osaka Univ.). Kakuyugo-Kenkyu, 18: 205-13(Feb. 1967). (In Japanese).

The helical instability and oscillations in extremely short positive columns immersed in longitudinal magnetic fields were experimentally investigated. It was found that several higher order modes of helical instabilities begin to grow in turn with azimuthal mode number m coexisting with helical m = 1 mode as the magnetic field increases above a critical field B_c for the m = 1 mode. With further increase of magnetic field nonlinear properties of the instabilities become predominant, resulting in the appearance of higher harmonics of the m = 1 mode. Oscillation frequency of the helix first increases with increasing magnetic field and finally decreases passing through a maximum in accordance with the nonlinear theory of Holter and Johnson. In a sufficiently short positive column, the plasma is always stable for all modes of instabilities independent of the magnetic field, being in good agreement with short column theory of Timofeev. (NSA of Japan)

37507 NEW APPROACH TO THE THEORY OF A TURBULENT PLASMA. Ichimaru, S. (Univ. of Illinois, Urbana); Nakano, T. Phys. Lett., 25A: 163-4(July 31, 1967).

A self-consistent approach to determine the fluctuation spectrum in the most stable state of a turbulent plasma is established. The contribution of the turbulent spectrum to the effective diffusion coefficient is also investigated. (auth)

37508 DISPERSION RELATION FOR MICROINSTABILITIES IN FINITE PLASMA. Cotsaftis, M. (EURATOM-CEA, Fontenay-aux-Roses, France). Phys. Lett., 25A: 170-1(July 31, 1967).

The dispersion for microinstabilities in a finite plasma is given. It contains a new term connected with the back and forth motion of the particles due to the mirror effect. (auth)

Thermonuclear Processes

37509 (FOA-4-4266-21) KATALYS MED MYMESONER AV FUSIONSREAKTIONER MELLAN VAETEISOTOPER. (Hydrogen Isotope Fusion Reactions by Muon Catalysis). Snellman, H. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Oct. 1966. 56p. (In Swedish). Dep.

During the past half decade information on experimental fusion reactions of hydrogen isotopes induced by muon catalysis has considerably increased. A review is given on the state of the art on the subject from reported experiments and theoretical calculations. These calculations are also extended to fusion reactions of tritium. The possibilities of gaining usable amounts of power are once more discussed. The conclusion is that this would probably not be possible. (SWEDEN)

Shielding

Refer also to abstracts 36317, 36319–36321, 38200, 38201, and 38235.

37510 (NASA-TN-D-4096) PLANE ISOTROPIC BUILDUP FACTORS FOR BREMSSTRAHLUNG CALCULATIONS. Burrell, M. O.; Watts, J. W. (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center). Aug. 1967. 30p. CFSTI.

Gamma-ray isotropic dose, energy flux, and energy current buildup factors for finite slabs were calculated by Monte Carlo techniques for initial energies ranging from 0.05 to 8.0 MeV with source backings from 0 to 3.0 mfp and source–exit plane distances from 0.5 to 7.0 mfp. Special emphasis was given to thin-source backings and to the energy range from 0.05 to 0.5 MeV for these thin-source backings. Low energies were needed for accurate bremsstrahlung dose calculations and other applications for which they had not been previously available. In comparisons of the calculated finite slab buildup factors to buildup factors for infinite media generated by the moments method, differences of up to 50% were observed. These differences were thought to be due mainly to geometric factors. (auth)

37511 (ORNL-P-3319) COMMENTS ON SHIELDING STANDARDS. Straker, E. A. (Oak Ridge National Lab., Tenn.). [1967]. Contract W-7405-eng-26. 10p. (CONF-670602-26). Dep. CFSTI.

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif.

Some brief comments are given on the need for setting up shielding standards or standard references. Some recent measurements made at the ORNL-TSF are discussed. (W.D.M.)

37512 USE OF FOOD AND METABOLIC WASTES FOR SPACE RADIATION SHIELDING. Jaffe, Raphael J. (Lockheed Missiles and Space Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc., 10: 12-13(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37513 ENGINEERING MODELS OF THE SPACE RADIATION ENVIRONMENT. Modisette, Jerry L.; Juday, Richard D.; Snyder, Joseph W. (Manned Spacecraft Center, Houston, Tex.). Trans. Amer. Nucl. Soc., 10: 373(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37514 CURRENT STATUS OF SPACE RADIATION EFFECTS ON MATERIALS AND COMPONENTS. Dye, David L. (The Boeing Co., Seattle). Trans. Amer. Nucl. Soc., 10: 373-4(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37515 STATUS OF RESEARCH TO DETERMINE RADIOBIOLOGICAL RESPONSE CRITERIA FOR SPACE MISSIONS. Ballinger, Edwin R. (USAF School of Aerospace Medicine, Brooks AFB, Tex.). Trans. Amer. Nucl. Soc., 10: 374(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37516 LET SPECTRUM OF GALACTIC RADIATION EXPOSURE IN SPACE AND ITS TRANSITION IN SHIELD OR TISSUE. Schaefer, Hermann J. (Naval Aerospace Medical Inst., Pensacola, Fla.). Trans. Amer. Nucl. Soc., 10: 374-5(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37517 SPECTRAL CHARACTERISTICS AND DOSE CALCULATIONS FOR THE PRIMARY AND SECONDARY PARTICLES THAT RESULT FROM THE INTERACTIONS OF THE SOLAR AND GALACTIC COSMIC RAYS WITH ALUMINUM SHIELDS. Curtis, S. B.; Wilkinson, M. C. (Univ. of California, Berkeley. The Boeing Co., Seattle). Trans. Amer. Nucl. Soc., 10: 375 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37518 STATUS AND PROSPECTS FOR PLASMA RADIATION SHIELDING. Levy, Richard H. (Avoc-Everett Research Lab., Everett, Mass.); French, Francis W. Trans. Amer. Nucl. Soc., 10: 376(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37519 QUASI-HOLLOW CONDUCTOR MAGNET AS A SPACE SHIELD AGAINST ELECTRONS. Levine, S. H.; Lepper, R. (Northrop Corp., Hawthorne, Calif.). Trans. Amer. Nucl. Soc., 10: 377(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37520 AN EXPERIMENTAL STUDY OF THE TRANSPORT OF ELECTRONS THROUGH THICK TARGETS. Jupiter, C. P.; Lonergan, J. A.; Merkel, G. (General Atomic Div., General Dynamics, Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 378-9(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37521 PENETRATION OF ELECTRONS AND ASSOCIATED BREMSSTRAHLUNG THROUGH ALUMINUM SHIELDS. Berger, Martin J.; Seltzer, Stephen M. (National Bureau of Standards, Washington, D. C.). Trans. Amer. Nucl. Soc., 10: 379-80(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37522 THEORY OF THE TRANSPORT OF RELATIVISTIC ELECTRONS. Scalettar, Richard (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 380(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37523 ANGULAR DISTRIBUTIONS OF THICK-TARGET BREMSSTRAHLUNG COMPARED WITH EXPERIMENT. Scott, W. Wayne (Chattanooga State Technical Inst., Tenn.). Trans. Amer. Nucl. Soc., 10: 380-1(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37524 SPECTRAL, ANGULAR, AND SPATIAL DISTRIBUTION OF ELECTRONS IN A SLOWING-DOWN MEDIUM. Nguyen, Dong Huu (Univ. of Texas, Austin); Grossman, Lawrence M. Trans. Amer. Nucl. Soc., 10: 381-3(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37525 PARAMETRIC TECHNIQUE OF COMPUTING PRIMARY ELECTRON DOSE. Hardy, Alva C.; Lopez, Manuel D.; White, Timothy T. (Manned Spacecraft Center, Houston, Tex.). Trans. Amer. Nucl. Soc., 10: 383(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37526 HIGH-ENERGY NUCLEON TRANSPORT. Alsmiller, R. G. Jr. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 384-5(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37527 NUCLEAR REACTION CROSS SECTION FOR SPACECRAFT SHIELD DESIGN. Peelle, R. W. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 385(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37528 SECONDARY-DOSE EQUIVALENT MODEL AND COMPARISON OF 160-MeV PROTON-INDUCED NEUTRON AND PROTON DOSE WITH A COMPREHENSIVE EXPERIMENT. Lilley, Bobby (North American Aviation, Downey, Calif.); Dunneer, Arthur G. Jr. Trans. Amer. Nucl. Soc., 10: 385-6 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37529 ANALYTIC REPRESENTATION OF NONELASTIC CROSS SECTIONS AND PARTICLE EMISSION SPECTRA FROM NUCLEON–NUCLEUS COLLISIONS IN THE ENERGY RANGE 25 TO 400 MeV. Alsmiller, R. G. Jr.; Leimdorfer, M.; Barish, J. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 386-7(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37530 PLANE ISOTROPIC BUILDUP FACTORS FOR BREMSSTRAHLUNG CALCULATIONS. Watts, J. W. (Marshall AFB, Huntsville, Ala.); Burrell, M. O.; Hill, C. W. Trans. Amer. Nucl. Soc., 10: 387-8(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37531 CALCULATIONS OF ELECTRON AND BREMSSTRAHLUNG PENETRATION AND DOSE RATES. Burrell, Martin O.; Wright, J. J. (Marshall AFB, Huntsville, Ala.). Trans. Amer. Nucl. Soc., 10: 388(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37532 EVALUATION OF GAMMA PROBE SHIELDING VERIFICATION FOR THE GEMINI AND APOLLO VEHICLES. Hardy, Alva C.; Snyder, Joseph W. (Manned Spacecraft Center, Houston, Tex.). Trans. Amer. Nucl. Soc., 10: 388-9(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37533 A COMPARISON OF MEASURED-TO-CALCULATED DOSE FOR THE GEMINI-IV AND -VI SPACE FLIGHTS AND WL-304 SPACE PROBE. Stovall, Robert L.; Case, Roger S. Jr.; Janni, Joseph F.; Schneider, Marion F. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Trans. Amer. Nucl. Soc., 10: 389-90(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37534 APPLICATION OF S_N ADJOINT FLUX CALCULATIONS TO MONTE CARLO BIASING. Cain, V. R. (Oak Ridge National Lab., Tenn.) Trans. Amer. Nucl. Soc., 10: 399(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37535 A V^0 IMPORTANCE FUNCTION FOR THE MONTE CARLO CALCULATION OF THE DEEP PENETRATION OF GAMMA RAYS. Armstrong, T. W.; Stevens, P. N. (Univ. of Tennessee, Knoxville). Trans. Amer. Nucl. Soc., 10: 399-400 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37536 POLYNOMIAL SOLUTIONS OF THE GAMMA-RAY TRANSPORT EQUATION IN INFINITE-HOMOGENEOUS AND TWO-MEDIUM PLANE GEOMETRY. Beck, Harold; Bennett, Burton (Atomic Energy Commission, New York, N. Y.). Trans. Amer. Nucl. Soc., 10: 400-1(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37537 APPLICABILITY OF SIMPLIFIED APPROXIMATION TECHNIQUES FOR AIR AND CONCRETE GAMMA-RAY SCATTERING. Warman, E. A.; Rogers, D. R.; Garrington, G.; Lindsey, B. A. (Aerojet-General Corp., Sacramento, Calif.). Trans. Amer. Nucl. Soc., 10: 401-2(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37538 FLUX-AT-A-POINT ESTIMATION FOR CYLINDRICALLY SYMMETRIC PROBLEMS. Troubetzkoy, E. S.; Cohen, M. O. (United Nuclear Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc., 10: 402-3(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37539 CALCULATIONS USING THE ALBEDO CONCEPT OF THE SUBCADMIUM FLUX ALONG THE CENTERLINES OF ONE-, TWO-, AND THREE-LEGGED SQUARE CONCRETE DUCTS ARISING FROM INCIDENT EPICADMIUM NEUTRONS: COMPARISON WITH EXPERIMENT. Maerker, R. E.; Muckenthaler, F. J. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 396-7(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37540 DEEP PENETRATION OF NEUTRONS IN IRON. Wagschal, J.; Levine, M. M.; Chernick, J. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 10: 397-8(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37541 EXPERIMENTAL INVESTIGATION OF BORON-CARBIDE-MODIFIED BERYLLIUM-OXIDE SHIELD MATRICES. Friedman, S. T. (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 10: 393-4(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37542 GAMMA-RAY SHIELDING STUDIES IN ALUMINUM AT 10 MeV. Lonergan, J. A.; Herring, D. F. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 394-5(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37543 INFLUENCE OF STRESSES DEVELOPED BY TENSIONING ON THE ABSORPTION AND SCATTERING OF GAMMA RAYS IN METALS. Zuchowski, Ryszard (Wroclaw Technical Univ.). Nukleonika, 12: 399-415(1967). (In Polish).

The effect of stresses in copper and steel samples on gamma ^{170}Tm radiation is discussed. Measurements were carried out with the help of a crystalline NaI(Tl) scintillation counter and a single-channel pulse amplitude analyzer. The intensity of radiation increased with increasing stress without measurable change in the thickness of the sample within the range of elastic strain. This phenomenon is reversible within the range of elastic deformation, but is irreversible within the range of plastic strain, where considerable changes in thickness of the sample take place. The stated changes in the radiation absorption in the material subjected to stresses are considered to be due to changes in radiation scattering, and thus in displacement of scattered radiation spectrum under the influence of the stresses applied. (auth)

37544 THE PROBLEM OF THE SPATIAL DISTRIBUTION OF SCATTERED γ RADIATION IN A CAVITY WHEN USING A COLLIMATED PRIMARY RADIATION SOURCE. Andryushin, N. F.; Bulatov, B. P. (At. Energy (USSR), 22: 415-16(May 1967). (In Russian).

In an investigation of the dependence of the spatial distribution of the scattered γ radiation in a spherical cavity with iron walls on the collimated primary γ radiation source, the beam of the ^{60}Co source, placed in the center of the cavity, was directed onto the wall, using a collimation aperture angle of 20°. A wall with an "infinite" thickness, $d > 3\lambda$, was used, whereby λ is the free path of primary quanta in the medium. In view of the similarity of the scattering properties of iron and concrete, the results are applicable to the latter material. Using the author's previously developed data in the equation of the angular distribution of the scattered γ radiation intensity, graphs were constructed, making it possible to calculate these intensities in laboratories in which experiments with ^{60}Co sources are carried out. (TTT)

37545 STOPPING POWERS FOR IODINE IONS AT ENERGIES UP TO 200 MeV. Bridwell, L. B.; Northcliffe, L. C.; Datz, S.; Moak, C. D.; Lutz, H. O. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev., 159: 276-7(July 10, 1967). (ORNL-P-2868).

Multicomponent beams of ^{127}I ions from an MP tandem accelerator have been used to extend some earlier stopping-power measurements for C, Al, Ni, Ag, Au, and UF_4 to energies up to 200 MeV. The expected maximum values of stopping powers have been reached in some cases. (auth)

37546 HIGH ENERGY X-RAY ALBEDO FOR Pb, Cu, AND DURALUMIN. Sugiyama, S.; Tomimasu, T. (Electrotechnical Lab., Tokyo). Nucl. Instrum. Methods, 53: 346-8(1967).

Angular distribution measurements of the energy albedo for Pb, Cu and duralumin irradiated by x-rays with maximum energy from 11.3 to 23.3 MeV were carried out by a plastic scintillation detector. Experimental results were used to determine the total energy albedo with an accuracy of the order of 12%. The energy albedo for Pb, Cu and duralumin are 2.4, 2.0, and 1.5% respectively at 23.2 MeV, and 1.7, 2.0, and 2.2%, respectively at 15.5 MeV. (auth)

Solid-State Physics

Refer also to abstracts 38167, 38283, and 38352.

37547 (UUIP-532) DE HAAS–VAN ALPHEN EFFECT IN p-TYPE Sb_2Te_3. Schwartz, H.; Bjoerck, G. (Uppsala Univ. (Sweden). Inst. of Physics). Apr. 1967. 22p. Dep.

The Fermi surface of Sb_2Te_3 ($n = 7.5 \times 10^{19}$ holes/cm^3) was studied by the dHvA effect. Ellipsoidal bandshape was verified. With the ellipsoids centered on mirror planes and the bisectrix taken as the x axis the components of the reciprocal effective mass tensor were: $Alpha_{11} = 0.75 \times 10^{14}\ E_F$; $Alpha_{22} = 1.50 \times 10^{14}\ E_F$; $Alpha_{33} = 0.76 \times 10^{14}\ E_F$; $Alpha_{13} = 0.75 \times 10^{14}\ E_F$. (auth) (Swed)

37548 COLOR CENTERS INDUCED BY NEUTRON IRRADIATION IN ZnS SINGLE CRYSTALS. Seiyama, Takeyoshi (Radiation Center of Osaka Prefecture, Sakai, Japan). J. Phys. Soc. Jap., 23: 525-36(Sept. 1967).

Correlations among the changes in optical density due to illumination with uv, 425-, or 540-mμ light have been examined for the uv, 390-, 425-, and 540-mμ bands introduced by neutron irradiation in ZnS single crystals. The photosensitive behavior before and after isochronal annealing of the samples and the analysis of the intensity distribution of the 425- and 540-mμ bands reveal that the 425-mμ band consists of a broad band and several narrow bands, and that the broad band and the 540-mμ band may have the same origin of absorption. The narrow 425-mμ band and the 390-mμ band disappear following isochronal annealing up to 340° and 480°C, respectively. The photosensitive uv band and the other visible bands begin to disappear at the 520°C step. Activation energy for the defects responsible for the 540-mμ band has been estimated to be 2.2 eV. A reasonable placement of the energy levels of these absorption centers was made. (auth)

37549 EFFECTS OF BREMSSTRAHLUNG ON THE LINEAR ABSORPTION COEFFICIENT FOR RELATIVISTIC ELECTRON DIFFRACTION. Ohtaka, K.; Ohtsuki, Y. H.; Yanagawa, S. (Tokyo Univ.). J. Phys. Soc. Jap., 23: 566-75(Sept. 1967).

The effect of bremsstrahlung processes is calculated for incident-beam energies between 10 and 2000 keV. The absolute value and the $\beta(= v/c)$ dependence of μ_0^{-1} are evaluated numerically, and it is shown that the effect considered here is very small as compared with the electronic excitation effect. (auth)

37550 OBSERVATION OF THE ^{141}Pr AND ^{169}Tm NUCLEAR MAGNETIC RESONANCES IN THE PARAMAGNETIC STATES OF RARE-EARTH INTERMETALLIC COMPOUNDS. Jones, E. D. (Sandia Corp., Albuquerque, N. Mex.). Phys. Rev. Lett., 19: 432-5(Aug. 21, 1967).

The first observations of the ^{141}Pr and ^{169}Tm NMR in rare-earth intermetallic compounds are described. The calculated and observed values for the NMR frequency shifts are in good agreement. (auth)

37551 SPATIAL DISTRIBUTION OF TRAPPED ELECTRONS AND HOLES PRODUCED BY X RAYS IN KI(Tl). Kaufman, R. Gilbert; Hadley, Wayne B. (Zenith Radio Corp., Chicago). J. Chem. Phys., 47: 264-9(July 1, 1967).

When KI(Tl) is irradiated at 78°K, trapped electrons and holes are produced. Warming mobilizes the holes which either recombine to give light or are trapped to give new absorptions. Light sum and absorption measurements show that the ratio of retrapping to recombination (R_h) for holes is independent of the concentration of electron and hole centers. Bleaching in the infrared frees trapped electrons, which either recombine giving light or are retrapped. The relative quantum efficiency, which is a measure of the ratio of retrapping to recombination (R_e) for electrons, is independent of the concentration of electron and hole centers. The stimulated electron recombination kinetics are first order with respect to concentration. From these facts it is suggested that the electron and hole are trapped near each other as a pair. (auth)

37552 ELECTRON SPIN RESONANCE STUDY OF TRAPPED ELECTRONS IN GAMMA-IRRADIATED TRIETHYLAMINE GLASSES. Tsujikawa, Hideo; Fueki, Kenji; Kuri, Zenichiro (Nagoya Univ., Japan). J. Chem. Phys., 47: 256-60(July 1, 1967).

A study has been made of trapped electrons produced in γ-ir-

radiated triethylamine glasses at low temperature by electron spin resonance methods. A sharp singlet centered at g = 2.003 ± 0.001 was observed, which was readily bleachable with near-infrared light. In the presence of an electron scavenger this singlet spectrum was not observed and it has been attributed to trapped electrons. The G value for the formation of trapped electrons has been estimated to be 0.5 at 77°K. Isothermal decay of trapped electrons at 77°K was found to be a first-order process. Thermal decay measurements of trapped electrons indicated their rapid disappearance in a temperature region 105° to 112°K. A nuclear magnetic resonance study of a triethylamine glass revealed that motional narrowing in a resonance line of solvent protons occurred in about the same temperature region as that in which the rapid decay of trapped electrons was observed. The nature of the electron trap is briefly discussed. (auth)

37553 SECONDARY ELECTRON EMISSION OF ALUMINIUM AND NICKEL FOR OBLIQUELY INCIDENT PRIMARY ELECTRONS. Bronshtein, I. M.; Denisov, S. S. (Gertsen Pedagogical Inst., Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 9: 731-2(Sept. 1967).

Translated from Fiz. Tverd. Tela, 9: 938-9(Mar. 1967).

The results of an investigation of the secondary electron emission of aluminum and nickel are reported for primary electrons incident at angles ≤60°. The value of the secondary emission parameters is given. (M.H.R.)

37554 EFFECT OF ELECTRON AND γ IRRADIATION ON VK-2 AND VK-4 TYPE "VARICONDS". Kuz'min, I. I.; Solov'ev, S. P.; Verbitskaya, T. N.; Kharchenko, V. A. Sov. Phys.-Solid State (Engl. Transl.), 9: 713-14(Sept. 1967).

Translated from Fiz. Tverd. Tela, 9: 918-20(Mar. 1967).

The effects of electron and γ irradiation on the electrical properties of "variconds" (variable capacitors) and on their structure was investigated. It was found that the nonlinear properties of variconds are suppressed as a result of the formation of radiation defects. (auth)

37555 EFFECT OF IRRADIATION ON THE DIFFUSIONAL-DISLOCATIONAL FLOW OF CRYSTALS. Kosevich, A. M.; Saralidze, Z. K.; Slezov, V. V. (Inst. of Physics and Tech., Kharkov). Sov. Phys.-Solid State (Engl. Transl.), 9: 697-703 (Sept. 1967).

Translated from Fiz. Tverd. Tela, 9: 895-904(Mar. 1967).

An analysis was carried out of the effects of irradiation on the mechanism of diffusional crystal flow, in the presence of bulk sources and discharge points for point defects in the form of prismatic dislocations. Account was taken both of further bulk sources of point defects and of radiational centers giving rise to dislocation loops. Relationships were derived between the rate of flow due to dislocation climb and the strength of these sources. (auth)

37556 RADIATION-STIMULATED DIFFUSION IN CADMIUM SULFIDE. Starodubtsev, S. V.; Niyazova, O. R.; Kaneev, M. A. (Inst. of Nuclear Physics, Tashkent). Sov. Phys.-Solid State (Engl. Transl.), 9: 679-81(Sept. 1967).

Translated from Fiz. Tverd. Tela, 9: 872-4(Mar. 1967).

The diffusion of the radiation defects induced by ^{239}Pu α particles accompanied by a background field of x rays or γ radiation is investigated. It is shown that the self-diffusion of cadmium is activated by irradiation. Neutron activation analysis is used to evaluate the amount of cadmium which comes out on the surface as a result of the simultaneous irradiation of CdS crystals by α particles and γ rays. (auth)

37557 INVESTIGATION OF THE PROCESS OF SORPTION OF OXYGEN ON (100) AND (110) FACES OF A TUNGSTEN SINGLE CRYSTAL USING THE ELECTRON-STIMULATED DESORPTION EFFECT. Zingerman, Ya. P.; Ishchuk, V. A. (Inst. of Physics, Kiev). Sov. Phys.-Solid State (Engl. Transl.), 9: 623-9(Sept. 1967).

Translated from Fiz. Tverd. Tela, 9: 797-804(Mar. 1967).

The phenomenon of electron-bombardment-stimulated desorption of a gas from the surface of a metal was used to investigate the interaction of oxygen with the surface of various faces of a tungsten single crystal. A method is proposed for a qualitative investigation of the sorption states of oxygen by analysis of the curves giving the dependence of the work function of a surface on the duration of electron bombardment, measured under various experimental conditions. This method was used to establish that the interaction of oxygen with tungsten on the (110) and (100) faces was basically different. On the (110) face the adsorbed atoms could be present only in one chemisorbed state, while on the (100) face there were many such states and one of them was the state of penetration of oxygen atoms under surface tungsten atoms. Such embedded oxygen atoms could reduce the work function of tungsten by 0.4 to 0.5 eV. The conditions for the population of the various sorption states of oxygen on the (100) face were determined and it was found that, in particular, at 1000°K the interaction of oxygen with tungsten ended by the formation, in addition to a multiphase adsorbed oxygen film, of a subsurface embedded zone of oxygen atoms. (auth)

37558 CALCULATION OF THE ENERGY DISTRIBUTION OF ELECTRONS TRANSMITTED THROUGH THIN FILMS OF MATTER. Akkerman, A. F.; Andreev, Yu. A.; Lyutov, Yu. G. (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Solid State (Engl. Transl.), 9: 599-603(Sept. 1967).

Translated from Fiz. Tverd. Tela, 9: 766-71(Mar. 1967).

A demonstration is given of the effectiveness of the Monte Carlo method in the calculation of the energy spectra and other characteristics of electrons transmitted through thin layers of matter. The results of calculations of the energy distributions are used to determine the dependence of the probability of formation of radiation defects in Si on the depth of penetration of the electron beam. (auth)

37559 INVESTIGATION OF THE MODULI OF ELASTICITY AND COMPRESSIBILITY OF EUROPIUM IN THE TEMPERATURE RANGE 70 TO 295°K. Burkhanov, A. M.; Grazhdankina, N. P.; Fakidov, I. G. (Inst. of Metal Physics, Sverdlovsk, USSR). Sov. Phys.-Solid State (Engl. Transl.), 9: 586-7(Sept. 1967).

Translated from Fiz. Tverd. Tela, 9: 748-50(Mar. 1967).

The results of an investigation of the temperature dependence of Young's modulus and the shear modulus and also of the coefficients of compressibility and thermal expansion of polycrystalline europium in the temperature range 70 to 295°K are reported. It is shown that all the above parameters undergo a sudden change at the antiferromagnetic transformation point (87°K). (auth)

37560 SLOW NEUTRON SCATTERING BY SPIN WAVES EXCITED BY FERROMAGNETIC RESONANCE. Maleev, S. V.; Stamenkovich, S. S. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 9: 575-8(Sept. 1967).

Translated from Fiz. Tverd. Tela, 9: 733-8(Mar. 1967).

Neutron scattering by spin waves excited by parametric ferromagnetic resonance in ferrites is considered. Expressions are obtained for the scattering cross section and polarization of scattered neutrons during parallel as well as transverse pumping. The experimental possibilities for the observation of such scattering are discussed. (auth)

37561 STUDY OF SOME TRAPPED HOLE CENTERS IN X-IRRADIATED ALKALI SILICATE GLASSES. Schreurs, J. W. H. (Corning Glass Works, N. Y.). J. Chem. Phys., 47: 818-30 (July 15, 1967).

A detailed study has been made of the EPR spectra of trapped hole centers formed by x irradiation in alkali silicate glasses. The spectra of the five alkali silicate glasses were studied as a function of composition, microwave power, and bleaching temperature. It was found that the spectra could be decomposed into two separate hole spectra. The intensity ratio of these two spectra depends on the alkali-to-silica ratio. The center more abundant in the low-alkali silicate glasses is called Hole Center 1, HC_1; the center more abundant in the high-alkali silicate glasses is called HC_2. Helpful in separating the two spectra was a dual cavity technique, which makes it possible to obtain sum and difference spectra. The spectra of both centers are fundamentally the same in all alkali silicate glasses, but differences in detail are shown to be due to a relatively small interaction with neighboring alkali ions. Both centers show a distribution in the thermal stability and associated spectral parameters. The proposed model for HC_1 is a hole located on a Si–O tetrahedron with two nonbridging oxygens, and with the hole presumably largely restricted to these nonbridging oxygens. The proposed model for HC_2 is quite similar, but the tetrahedron now has three nonbridging oxygens. A comparison of the optical and EPR difference spectrum of two potassium silicate glasses with different (K_2O)-to-(SiO_2) ratios suggests that the 475-nm optical absorption band may be due to HC_1. (auth)

37562 ELECTRON SPIN RESONANCE ABSORPTION SPECTRUM OF ORTHORHOMBIC CO_3^- MOLECULE–IONS IN IRRADIATED SINGLE CRYSTAL CALCITE. Serway, R. A. (IIT Research Inst., Chicago); Marshall, S. A. J. Chem. Phys., 47: 868-9(July 15, 1967).

The ESR absorption spectrum of γ-irradiated single-crystal calcite, at temperatures below 175°K, exhibited orthorhombic symmetry and consisted of six equally intense lines. Comparison of the weighted averages of the principal g values of this spectrum with those of the axially symmetric CO_3^- molecule–ion suggests that the six-line spectrum is due to distorted CO_3^- molecule–ions that occupy six magnetically inequivalent sites. The mechanism giving rise to the orthorhombic nature of the CO_3^- molecule–ion may be a neighboring vacancy or impurity

acting as a local charge compensator, which destroys the three-fold axial symmetry of the specific carbonate-ion site. Thermal decay measurements on the spectrum at 145 and 155°K indicate first-order kinetics with an activation energy of 0.53 ± 0.05 eV. (A.G.W.)

37563 IRRADIATION OF THIN LAYERS OF CdTe BY CADMIUM IONS. Smirnov, L. S.; Kachurin, G. A.; Gorodetskii, A. E. (Inst. of Semiconductor Physics, Novosibirsk, USSR). Sov. Phys.-Solid State (Engl. Transl.), 9: 564-6(Sept. 1967).
Translated from Fiz. Tverd. Tela, 9: 719-22(Mar. 1967).

Changes in the electrophysical properties of CdTe films caused by Cd^+ ion bombardment were investigated. Photosensitive n-type films with an electron mobility of about 100 $cm^2/V \cdot sec$ were produced. The formation of complexes as a result of ion bombardment is suggested on the basis of the experimental data. (auth)

37564 STACKING FAULTS IN A NON-STOICHIOMETRIC FACE-CENTERED CUBIC TaC. Martin, J. L. (Office National d'Etudes et de Recherches Aerospatiales, Chatillon/Bagneux, France); Jouffrey, B.; Costa, P. Phys. Status Solidi, 22: 349-53(1967).

Stacking faults are observed by transmission electron microscopy in face-centered-cubic $TaC_{0.75}$. These stacking faults have the same contrast as intrinsic faults in face-centered-cubic metals; they do not exist in nearly stoichiometric carbides. No metallic plane relaxation is detected in the neighborhood of a fault. It seems that another carbide phase precipitates along the fault planes in a Widmanstätten structure. (auth)

37565 DAMAGE FORMATION RATES IN Ge SUBJECT TO THERMAL TREATMENT. Khansevarov, R. Yu.; Mashovets, T. V.; Vitovskii, N. A. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Status Solidi, 22: K103-7(1967).

It is well known that impurities strongly influence the process of radiation damage formation. Results are presented on the influence of impurity extraction upon the formation of stable γ-radiation defects in Ge. In both irradiation and heat-treatment processes nonequilibrium vacancies are introduced. A rise of the radiation stability of n-Ge can be expected as a result of the extraction of impurities. (W.D.M.)

37566 ON THE NATURE OF DAMAGES IN INDIUM ANTIMONIDE PRODUCED BY γ AND X IRRADIATION. Khansevarov, R. Yu. (Ioffe Inst. of Physics and Tech., Leningrad); Mashovets, T. V.; Vitovskii, N. A.; Chelustka, B. Phys. Status Solidi, 22: K95-K101(1967).

Defects in InSb induced by ^{60}Co γ rays and 55-kV peak voltage x rays were investigated. The experiments included carrier concentration measurements at 78°K after different doses of γ rays or x rays as well as after isochronal and isothermal annealing. (W.D.M.)

37567 EFFECTS OF FAST NEUTRONS ON ELECTRIC PROPERTIES OF NiO SINGLE CRYSTALS. Cojocaru, L. N. (Inst. for Atomic Physics, Bucharest). Phys. Status Solidi, 22: 361-4 (1967).

A study is made of the effect of fast neutrons on the electric conductivity and thermoelectric power of NiO single crystals. It is found that the conductivity and thermoelectric power are reduced after an irradiation of about 10^{17} nvt. This is explained by assuming that the defects introduced into the NiO lattices act as acceptors and not as trapping centers for holes. The decrease of the electric conductivity is due to the mobility decrease while the decrease in the thermoelectric power arises from the increase of the hole concentration. (auth)

37568 SPONTANEOUS RECOMBINATION OF FRENKEL PAIRS FOR ELECTRON IRRADIATION. Dettmann, K.; Leibfried, G.; Schroeder, K. (Technische Hochschule, Aachen). Phys. Status Solidi, 22: 423-32(1967).

The damage rate for electron irradiation is calculated from the general equations for the spontaneous recombination of Frenkel pairs. The calculation uses the superposition approximation in which third-order correlations are replaced by second-order correlations. Comparison with the measurements of Dworschak et al. for 3-MeV electrons gives for copper an annealing volume, v_a = 200 atomic volumes, and a fraction $\gamma = 0.1$ of interstitials, originally in unstable positions around their corresponding vacancies. (auth)

37569 SPONTANEOUS RECOMBINATION OF FRENKEL PAIRS IN NEUTRON-IRRADIATED SOLIDS. Dettmann, K.; Leibfried, G.; Schroeder, K. (Technische Hochschule, Aachen). Phys. Status Solidi, 22: 433-40(1967).

The accumulation of Frenkel defects in neutron-irradiated solids is studied using a simple model of a displacement cascade. The lowering of the damage rate by spontaneous recombination of unstable Frenkel pairs is taken into account. The general equations are solved using the superposition approximation in which third-order correlations are replaced by products of second-order correlations. The saturation density of defects and the damage rate as a function of the density are calculated. By comparison with experiment the annealing and cascade volumes can be deduced for various metals. (auth)

37570 ROLE OF γ-RADIATION INTENSITY ON THE FIRST STAGE OF THE ROOM-TEMPERATURE F-COLORING IN NaCl. Agullo-Lopez, F. (Junta de Energia Nuclear, Madrid). Phys. Status Solidi, 22: 483-90(1967).

An investigation was made of the effect of γ-ray intensity (within the range 500 to 30,000 R/min) on the first stage of room-temperature F coloring in NaCl. In accordance with recent work, the first stage is found to consist of two different components (fast and slow), both of which are observed to be approximately exponential. The saturation value for the fast component seems to be independent of intensity, whereas that for the slow component increases with intensity in the same way as the total saturation level. The observed growth rates are not monotonic over the entire intensity range. However, for intensities ≥1000 R/min, the growth rate for both the fast and the slow processes appears to be a decreasing function of γ-radiation intensity. A brief qualitative discussion of these results in terms of a simple model is presented. (auth)

37571 NEUTRON-DIFFRACTION STUDY OF ANTIFERROMAGNETISM IN USb_2 AND UBi_2. Leciejewicz, J. (Inst. of Nuclear Research, Swierk/Otwock, Poland); Murasik, A.; Troc, R.; Zygmunt, A. Phys. Status Solidi, 22: 517-26(1967).

The magnetic ordering in polycrystalline USb_2 and UBi_2 is studied by means of neutron diffraction. It is found that the magnetic unit cell of USb_2 is twice the size of the chemical cell along the c axis, with alternating ferromagnetic sheets in the sequence $+ - - + \cdots$. In the case of UBi_2 the magnetic and chemical unit cells are identical. The sequence of ferromagnetic sheets is $+ - + - \cdots$ in the direction of the c axis. In both cases magnetic moments are parallel to the c axis and their magnitudes are (0.94 ± 0.03) BM for USb_2 and (2.1 ± 0.1) BM for UBi_2. (auth)

37572 ANISOTROPIC ISOTOPE EFFECT FOR DIFFUSION OF ZINC AND CADMIUM IN ZINC. Batra, A. P. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., 159: 487-99(July 15, 1967).

The sectioning technique and the half-life method of isotope discrimination were used to study the relative rates of diffusion of ^{65}Zn and ^{69m}Zn, and of ^{109}Cd and ^{115}Cd in high-purity zinc single crystals. The isotope effect, $E_f^g = (1 - D^\alpha/D^\beta)/[1 - (m^\beta/m^\alpha)^{1/2}]$, was measured; D^α/D^β and m^α/m^β are the ratios of the diffusion coefficients and of the masses of the two isotopes α and β, respectively. The average of the values of $E_{\parallel}^{Zn}$ at 411.6 and 382.8°C for diffusion of zinc isotopes in zinc, parallel to the hexagonal axis, is 0.669 ± 0.024, whereas the corresponding value perpendicular to the hexagonal axis is 0.687 ± 0.022. These results are consistent with diffusion by vacancy (basal and nonbasal) mechanisms and appear to rule out the interstitial, ring, interstitialcy, and crowdion as the dominant mechanism. The observed isotope effect, both for parallel and perpendicular diffusions, is thus about 13% less than the value predicted on the basis of the inverse-square-root mass dependence of the atomic jump frequency, i.e., the correlation factor for self-diffusion. This deviation is apparently due to many-body aspects of diffusion, and on these considerations it is concluded that a small fraction (about 13%) of the translational kinetic energy of the activated state is possessed by atoms other than the jumping atom. At 410.1°C, the values of $E_{\parallel}^{Cd}$ for diffusion of cadmium isotopes in zinc, parallel and perpendicular to the hexagonal axis, are 0.507 ± 0.034 and 0.317 ± 0.032, respectively. These values indicate an attractive interaction between the cadmium impurity and the vacancy, the interaction being larger when both of them are in the same basal plane. Under the assumption that the many-body consideration is essentially the same as for self-diffusion, and by making some reasonable simplifying approximations as to how the presence of the impurity influences the vacancy jump, the enhancement of cadmium diffusion over zinc diffusion is examined. It is found that the rapid interchange of the cadmium impurity with the vacancy and the greater density of the vacancies next to the cadmium impurity are both responsible for the enhancement in the diffusivity of cadmium in zinc. (auth)

37573 SUPPORTING EVIDENCE FOR LONG-RANGE DEFECT MIGRATION IN THE STAGE-I RECOVERY OF COPPER. Coltman, R. R. Jr.; Klabunde, C. E.; Redman, J. K. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev., 159: 521-6(July 15, 1967). (ORNL-P-2838).

From the measurement of electrical-resistivity changes, an irradiation doping effect upon the stage-I recovery of thermal-

neutron damage in copper has been observed. Because small defect concentrations (3.5×10^{-8} atomic concentration of Frenkel pairs) were employed, the results strongly support the idea of long-range defect migration in the stage-I recovery. Isochronal-annealing studies of dilute damage characterize the recovery in stage I_D and I_E, and the results can be interpreted in terms of long-range interstitial migration in stage I_E. (auth)

37574 ELECTRONIC STRUCTURE OF ZIRCONIUM. Loucks, T. L. (Ames Lab., Iowa). Contract W-7405-eng-42. Phys. Rev., 159: 544-51(July 15, 1967). (IS-1482).

Augmented-plane-wave (APW) calculations of the electronic structure of zirconium have been carried out. The resulting Fermi surface is almost entirely different from the model proposed earlier by Altmann and Bradley on the basis of cellular calculations. The APW Fermi surface (after slight modification) can account for the angular dependence of the de Haas–van Alphen periods observed by Thorsen and Joseph; the theoretical values of the periods differ from the experimental results by no more than about 40%. Although this is by no means an outstanding example of close agreement between experimental and theoretical results, it is believed that the new Fermi-surface model represents a substantial improvement over previous work and is a better starting point for any future attempts to deduce an improved model whenever additional experimental data become available. (auth)

37575 ION-NEUTRALIZATION SPECTROSCOPY OF COPPER AND NICKEL. Hagstrum, H. D.; Becker, G. E. (Bell Telephone Labs., Inc. Murray Hill, N. J.). Phys. Rev., 159: 572-85(July 15, 1967).

Experimental results concerning the band structure of copper and nickel have been obtained by a new method of electronic spectroscopy of solids. The spectroscopic information comes from deconvolution of the kinetic-energy distribution of electrons ejected in the radiationless, two-electron neutralization of slowly moving noble-gas ions at the solid surface. This leads to a transition density function which includes information about the density of states in the filled conduction band, transition probabilities of the Auger-type neutralization process, and possible many-body effects and final-state interactions. Data are presented for the atomically clean (111), (110), and (100) faces of both Cu and Ni, and for the ions He^+, Ne^+, and Ar^+. Transition probability factors depending on band energy, symmetry character of the band electron's wave function, and crystallographic orientation are evident in the results. The data are entirely consistent with the rigid-band model. Measurements above and below the Curie point for Ni are consistent with a spin-exchange energy of, at most, a few tenths of an eV. The large resonance centered at 4.5 eV below the Fermi level reported by photoelectric emission is not observed in this work. The same statement can be made concerning the resonance reported for Cu at 6 eV below the Fermi level. Detailed comparison is made with the results of band-structure calculations and with the experimental results from photoelectric emission and the soft-x-ray spectroscopy. (auth)

37576 ELECTRON RADIATION DAMAGE IN CADMIUM-SELENIDE CRYSTALS AT LIQUID-HELIUM TEMPERATURE. Schulz, H. J.; Kulp, B. A. (Aerospace Research Labs., Wright-Patterson Air Force Base, Ohio). Phys. Rev., 159: 603-9 (July 15, 1967).

CdSe crystals grown by the vapor-deposition method show a cathodoluminescence spectrum at 5°K with peaks at 1.34 and 1.74 eV. Under electron bombardment, above an energy threshold of 320 keV, a new emission band at about 1.1 eV is produced. An isochronal annealing experiment shows the annihilation of the damage in one step at 62°K. Previous experiments at 77°K showed a threshold at 250 keV for the generation of a fluorescence band at 0.99 eV. The threshold observed at 320 keV is assigned to the displacement of a cadmium atom with an energy transferred of 8.1 eV. The threshold at 250 keV is assigned to the displacement of the selenium atom with an energy transferred of 8.6 ev. (auth)

37577 ELECTRON SCATTERING BY PAIR PRODUCTION IN SILICON. Kane, E. O. (Bell Telephone Labs., Inc. Murray Hill, N. J.). Phys. Rev., 159: 624-31(July 15, 1967).

The energy-dependent rate for inelastic scattering of electrons by production of electron–hole pairs is computed by first-order perturbation theory for silicon using a screened Coulomb interaction with a frequency- and momentum-dependent dielectric function calculated for silicon in the random-phase approximation. The threshold for momentum-conserving pair creation is found to be very close to that determined by energy conservation alone. This follows from the silicon band structure. The absolute scattering rate is close to that obtained experimentally by Bartelink, Moll, and Meyer. Pair production dominates the scattering rate for electrons of energy greater than 6.5 eV above the valence-band maximum. For electrons between 4 and 6.5 eV the scattering rate is dominated by phonon scattering, but energy loss is dominated by pair scattering. Below 4 eV phonon processes dominate inelastic processes as well. The momentum space integrals for pair-creation scattering are performed by a Monte Carlo method. It is found that the calculations with momentum conservation can be reproduced surprisingly well by a simple "random-k" approximation, which effectively ignores momentum conservation. This leads to a very simple expression for pair scattering in the form of a two-dimensional energy fold over one-electron state-density functions, a result first obtained by Berglund and Spicer. This simple form facilitates the calculation tremendously and should make calculations for other materials very simple if the state-density function is known. Using this "random-k" method, the scattering rate for primary holes is obtained and found to be almost identical with that for primary electrons of comparable energy. The secondary-particle energy distribution functions are also determined for primary holes and electrons. One-electron state-density structure is prominent in these distributions. (auth)

37578 DYNAMICS OF RADIATION DAMAGE IN FACE-CENTERED-CUBIC ALKALI HALIDES. Torrens, Ian McC.; Chadderton, Lewis T. (North American Aviation Science Center, Thousand Oaks, Calif.). Phys. Rev., 159: 671-82(July 15, 1967).

Computer simulations of ionic motion in 3-dimensional potassium chloride and sodium chloride crystallites have been undertaken to investigate the effect of the regular lattice in influencing the energy spread in the crystal from a primary event such as might be caused by an incident energetic charged particle. Focusing of energy has been found to occur in several low-index crystallographic directions, including those where successive collisions involve oppositely charged ions. The neighboring assisting lines of ions exert considerable influence on the rate of energy loss along the focusing line, on the solid angle in which focusing occurs, and on the threshold energy for permanent ionic displacement from a lattice site, which was found to be a minimum of 25 to 30 eV in the ⟨110⟩ directions of potassium chloride. The feasibility of some mechanisms of F-center formation through ionic displacement is discussed in the light of this value of displacement threshold. The computations reveal a new concept of focusing, for which there is a lower energy limit for propagation of a focuson. This limit can be as high as several hundred electron volts for higher-order focusing through asymmetric assisting ionic "lenses." At energies above the lower focusing-energy limit, the momentum transfer of the moving ion to its neighbors between focusing collisions is sufficiently small compared to its forward momentum for its trajectory to be altered only slightly by collision with different parts of the assisting lens. At lower energies, asymmetric collisions with lens ions result in defocusing. (auth)

37579 COVALENT INTERACTION IN THE PROCESS OF M^+-CENTER FORMATION. Farge, Y.; Lambert, M.; Smoluchowski, R. (Centre National de la Recherche Scientifique, Orsay, France). Phys. Rev., 159: 700-2(July 15, 1967).

The formation of M centers out of α and F centers in LiF is preceded by the formation of $M^+ = F_2^+$ centers. It is shown that the observed activation energy and the pre-exponential factor for the formation of M^+ centers, as well as their total number, can be accounted for by the existence of a covalent bond between the two vacancies. (auth)

37580 THERMOLUMINESCENCE AND F-CENTER BLEACHING IN HEAVILY IRRADIATED KCl. Sonder, E.; Sibley, W. A.; Mallard, W. C. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev., 159: 755-60(July 15, 1967). (ORNL-P-2910).

The possibility that thermoluminescence from KCl crystals electron irradiated at 80°K can cause optical bleaching of the crystals and be responsible for the aggregation of F centers has been investigated. It was found that even though two of the thermoluminescent glow peaks occurred at the temperatures where F′ centers annealed out (200°K) and M centers were formed (260°K), the intensity of the luminescence was much too weak to be the cause of the observed changes. Furthermore, F-center annealing was observed to occur over a broad temperature range and could not be correlated with any particular glow peak. Three different emission spectra were observed, each being characteristic of a different temperature range. (auth)

37581 LATTICE DEFECTS IN KCl WITH COLOR CENTERS. Balzer, R.; Peisl, H.; Waidelich, W. (Technische Hochschule, Darmstadt, Ger.). Z. Phys., 204: 405-18(1967). (In German).

Color centers were created in KCl single crystals by additive coloration and x irradiation at room temperature. Change of lattice parameter was determined by an x-ray method and change of mass density by a hydrostatic flotation method. Combination of these re-

sults, together with optical absorption measurements, led to the following results: F centers in additively colored KCl are Schottky defects. They cause a lattice expansion $\Delta v/v = 0.58$ per F center. F centers in x-irradiated KCl are parts of Frenkel defects. During irradiation atoms are displaced to interstitial lattice sites. The volume expansion is $\Delta v/v = 1.15$ per F center. (auth)

37582 MULTIPLE COLLISIONS IN THE SCATTERING OF IONS BY CRYSTALS. Mashkova, E. S.; Molchanov, V. A. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 172: 813-16(1967). (In Russian).

It was reported earlier that peaks due to multiple collisions are present in the spectra obtained during the scattering of ions by the surface of crystals. Further studies were carried out on nickel crystals in order to determine the correlations between these peaks and the distance between the scattering atoms. The influence of the atomic number was also studied, using the 30-keV $^{20}Ne^+$ and $^{40}Ar^+$ and the 25-keV ^{84}Kr ions as the incident radiation. It was found that the relative intensity of the twofold collision in the case of Ne is lower than in the case of argon. Scattering of the ions by polycrystalline tungsten yielded a relatively narrow spectrum for neon, with a weak portion attributable to multiple scattering; this portion was found to become increasingly stronger for argon and krypton. The observations agree with conclusions based on the simplest two-atomic scattering model, under consideration of the interaction based on the Firsov potential, according to which the relative probability of the twofold scattering increases directly with the atomic number of the ion and atom involved and inversely with the energy and angle of scattering, and distance between the scattering atoms. (TTT)

37583 CHANNELING: A NEW TOOL IN CRYSTALLOGRAPHY AND SOLID STATE INVESTIGATIONS. Davies, J. A. (Chalk River Nuclear Labs., Ont.). Phys. Can., 23: No. 3, 13-21(Summer 1967).

The discovery and the experimental and theoretical development of the phenomenon of channeling are reviewed. Applications of the channeling effect of orientation of single crystals, measurement of the extent of lattice damage, and location of certain foreign atoms in crystals are briefly discussed. (A.G.W.)

37584 SINGLE-CRYSTAL X-RAY DIFFRACTION USING PHOTONS FROM TWO RADIOACTIVE ISOTOPIC SOURCES. Preuss, Luther E.; Toothacker, William S.; Bugenis, Claudius K. (Edsel B. Ford Inst. for Medical Research, Detroit). J. Appl. Phys., 38: 3404-5(July 1967).

A single crystal of LiF was substituted for previously used powder samples in a study of Bragg diffraction of MnKα x rays using a 100-mCi ^{55}Fe source. A satisfactory LiF diffraction pattern (200 plane) was obtained. Diffraction intensity in the main beam was about 2.5×10^2 times that obtained with the LiF powder. A preliminary study indicated that a resolution of 17.4′ FWHM was obtainable with this source. These results were used to predict diffraction using a $^{147}Pm-Cu$ source. Such a source was constructed, and a diffraction intensity of the order of 16 counts/min was obtained experimentally as compared with a predicted intensity of 10 to 20 counts/min. Further experiments on these sources are being carried out. (A.G.W.)

37585 COMPUTER STUDIES OF XENON-ION RANGES IN A FINITE-TEMPERATURE TUNGSTEN LATTICE. Harrison, D. E. Jr.; Greiling, D. S. (Naval Postgraduate School, Monterey, Calif.). J. Appl. Phys., 38: 3200-11(July 1967).

The passage of heavy ions through a tungsten crystal in which the atoms are thermally displaced and the ions are subjected to a force that represents inelastic-loss mechanisms is simulated. Semiempirical Born–Mayer potential functions and inelastic-loss parameters were obtained for the xenon–tungsten and krypton–tungsten systems. Only the xenon–tungsten system was studied in detail. It was found that below 500°K thermal displacement of the lattice atoms has little effect upon the collision dynamics for ions moving in the channel center. Energy losses to electronic processes during collisions are calculated, and the loss rates compared to the simulation loss rate parameter. Agreement is good. Simulated integral-penetration curves agree quite well with the experimental results. A mechanism that attributes the strong temperature dependence of ranges to variations in the inelastic-loss constants is presented and compared to experimental results. (auth)

37586 DIFFUSIONAL PROPERTIES OF THE STAGE-III DEFECT IN COPPER. I. EXPERIMENTAL RESULTS. Thompson, D. O. (North American Aviation Science Center, Thousand Oaks, Calif.); Buck, O.; Barnes, R. S.; Huntington, H. B. J. Appl. Phys., 38: 3051-6(July 1967).

Measurements of the effects of ^{60}Co γ irradiation have been made upon the dislocation internal friction and modulus defect in copper single crystals from 333° to 393°K. It is found that the number of pinning points nucleated on the in-grown dislocations by the lattice defects produced by the irradiation depends upon the γ-ray flux, or more directly, upon the concentration of defects in the dislocation core. At the smallest flux level available (1.3×10^9 photons/cm^2/sec), it is found that the dislocation-defect trapping curves are essentially linear, and that the slopes of the linear curves vary exponentially with temperature. These results form the basis of the analyses given in Parts II and III of this series. (auth)

37587 DIFFUSIONAL PROPERTIES OF THE STAGE-III DEFECT IN COPPER. II. A MODEL FOR DEFECT-DISLOCATION INTERACTIONS. Thompson, D. O. (North American Aviation Science Center, Thousand Oaks, Calif.); Buck, O.; Huntington, H. B.; Barnes, P. S. J. Appl. Phys., 38: 3057-67(July 1967).

The experimental results given in Part I are used as a guide, in development of a linear model that describes the interaction of a lattice defect and a dislocation. It is supposed in this model that the defect is free to diffuse between existing (or in-grown) traps such as jogs or dislocation nodal points, and that if the defect is trapped, dislocation climb follows. From a comparison of the results given in Part I and the predictions of the model, values for the "pipeline" duffusivity and the strength of the binding of the defects to the in-grown nodal points may be obtained. The numbers so obtained are consistent with values evolved from other techniques for studying atom motions. An estimate for diffusional jog-pair energies is also given. (auth)

37588 DIFFUSIONAL PROPERTIES OF THE STAGE-III DEFECT IN COPPER. III. BULK DIFFUSION. Thompson, D. O.; Buck, O. (North American Aviation Science Center, Thousand Oaks, Calif.). J. Appl. Phys., 38: 3068-74(July 1967).

An analysis of the bulk diffusion properties of the stage-III defect is given utilizing the experimental results presented in Part I. It is found that the motion energy of the defect is 0.64 ± 0.03 eV and, in addition, it is shown that this is a true motion energy and not a defect–impurity-atom binding energy. After consideration of the extremely small lattice-defect concentrations used ($\leq 10^{-12}$), available information concerning single-vacancy motion energies, and the simple-defect spectrum produced by the γ irradiation, it is concluded that the stage-III defect can only be identified as a freely migrating interstitial atom. (auth)

37589 RADIATION DAMAGE IN MgO. Sibley, W. A.; Chen, Y. (Oak Ridge National Lab., Tenn.). Phys. Rev., 160: 712-16 (Aug. 15, 1967). (ORNL-P-2909).

The radiation production of F centers in Fe-doped and pure MgO crystals has been investigated. The coloration is enhanced by impurities when the radiation temperature is in the range 80 to 330°K. Unlike the more ionic alkali halides, the F-center production rate is a linear function of electron-irradiation intensity and decreases with irradiation energy. For a given dose of radiation, fast neutrons produce about 50 times as many F centers as do energetic electrons. It is concluded from the study that radiation damage in MgO occurs primarily as a result of elastic collisions, and that the photochemical processes prevalent in the alkali halides contribute very little, if any, to the damage. (auth)

37590 EFFECTS OF ELECTRON IRRADIATION ON THE THERMAL CONDUCTIVITY OF n- AND p-TYPE GERMANIUM. Albany, H. J.; Vandevyver, M. (Centre d'Etudes Nucleaires, Saclay, Gif-sur-Yvette, France). Phys. Rev., 160: 633-5(Aug. 15, 1967).

The change in the low-temperature thermal conductivity K of antimony-doped germanium was investigated in the n-to-p-type conversion region induced by 4-MeV electron irradiation (1.3×10^{17} to 1.6×10^{18} electrons/cm^2) performed at about 40°C. The thermal conductivity was found to decrease in the neighborhood of the peak and just below it, after the first electron dose (1.3×10^{17} electrons/cm^2). With higher electron fluxes, K increased over the whole temperature range 5 to 80°K, reaching values higher than that of unirradiated germanium. The initial decrease of K is at present not well understood, but is likely to be related to scattering of phonons by bombardment-introduced levels. The further increase of K appears to be characteristic of the depletion of donor electrons by radiation-induced acceptor defects. This explanation is consistent with the Keyes model relative to scattering of phonons by occupied donors. No noticeable change in K was obtained in p-type germanium for electron doses up to 1.7×10^{18} electrons/cm^2. This behavior indicates that either the radiation-induced levels involve no particular modification of the initial scattering mechanisms, or most likely the defect introduction rate is much lower than in n-type, the small amount of defects produced being of negligible effect on K. (auth)

37591 ROWS OF DISLOCATION LOOPS IN ALUMINUM IRRADIATED BY ALUMINIUM IONS. Henriksen, L. (Univ. of

Copenhagen); Johansen, A.; Koch, J.; Andersen, H. H.; Cotterill, R. M. J. Appl. Phys. Lett., 11: 136-8(Aug. 15, 1967).

Single-crystal aluminum specimens, irradiated with 50-keV aluminium ions, contain dislocation loops that are arranged in regular rows along ⟨110⟩ directions. (auth)

37592 BOMBARDMENT OF THIN CdTe FILMS WITH INDIUM IONS. Kachurin, G. A.; Gorodetskii, A. E.; Loburets, Yu. V.; Smirnov, L. S. (Inst. of Semiconductor Physics, Novosibirsk, USSR). Sov. Phys.-Solid State (Engl. Transl.), 9: 375-8(Aug. 1967).

Translated from Fiz. Tverd. Tela, 9: 494-7(Feb. 1967).

Thin CdTe films were bombarded with indium ions of energies 2 to 40 keV using doses of 0 to 3 mC and various substrate temperatures. It was found that the efficiency of doping by bombardment depended on the ion energy and on temperature. A hypothesis is made for the formation of complexes between indium atoms and structure defects. Also, the results obtained by annealing the irradiated CdTe films are reported. (auth)

37593 CONCERNING THE EFFECT OF THERMAL DEFECTS ON THE RADIATION STABILITY OF GERMANIUM. Mashovets, T. V.; Ryvkin, S. M.; Khansevarov, R. Yu. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 9: 407-10(Aug. 1967).

Translated from Fiz. Tverd. Tela, 9: 535-8(Feb. 1967).

The effect of extraction of residual copper on the rate of formation of defects in germanium by γ irradiation has been investigated. The extraction of copper did not have any effect on this rate. The initial rate of defect formation was decreased, however, if the germanium was heated in the presence of gold and then quenched; this resulted in the introduction of thermal defects having energy levels at $E_c - 0.2$ eV. These centers (possibly dislocations) apparently are sinks for radiation defects. In the case of the normal (without gold) thermal treatment of germanium, in addition to the copper levels, acceptor levels lying below the level of the copper atoms at $E_V + 0.04$ eV also play an important role in changing the parameters of the material. The nature of these levels is studied. (auth)

37594 CATHODOLUMINESCENCE OF SiC CRYSTALS OF VARIOUS MODIFICATIONS CONTAINING RADIATION DEFECTS. Makarov, V. V. (Kalinin Polytechnic Inst., Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 9: 457-60(Aug. 1967).

Translated from Fiz. Tverd. Tela, 9: 596-600(Feb. 1967).

The effects of ion bombardment (involving various gas and alkali-metal ions with energies up to 20 keV) and irradiation by fast electrons (2 MeV) on the cathodoluminescence of single crystals of silicon carbide having the 4H, 6H, 15R, and 3C modifications have been investigated. It was found that irradiation of the samples by ions (independent of the nature of the ions) or by fast electrons followed by annealing at 1000 to 1200°C leads to a change in the spectral distribution and to a considerable increase in the luminescence intensity. The spectral distribution of radiation from crystals of various modifications has been studied. A number of possible applications of the observed phenomena are presented. (auth)

37595 PARTICIPATION OF FOCUSED COLLISIONS CAUSED BY IRRADIATION IN THE DEFORMATION OF METAL CRYSTALS. Troitskii, O. A. (Solid-State Physics Inst., Chernogolovka, USSR). Sov. Phys.-Solid State (Engl. Transl.), 9: 498-500(Aug. 1967).

Translated from Fiz. Tverd. Tela, 9: 647-50(Feb. 1967).

The anisotropy of the effect of irradiation with particles of 1- to 5-MeV energy on the process of deformation of zinc single crystals is explained by the interaction of focused collisions with dislocations in the zinc lattice. Data were obtained on the influence of the energy and number of particles, the degree of preliminary deformation of the samples, and the rate of elongation before irradiation on the observed anisotropy. (auth)

37596 INFLUENCE OF TEMPERATURE ON THE DISTRIBUTION OF THE LENGTHS OF CORRELATED COLLISION CHAINS OCCURING IN CASCADES DURING THE IRRADIATION OF COPPER CRYSTALS. Pugacheva, T. S.; Safarbaev, I. (Inst. of Nuclear Physics, Tashkent). Sov. Phys.-Solid State (Engl. Transl.), 9: 508-9(Aug. 1967).

Translated from Fiz. Tverd. Tela, 9: 659-61(Feb. 1967).

Previously obtained relationships for the successive angles and energies in a chain of correlated collisions, allowing for thermal vibrations, were used to calculate the lengths of such chains in Cu at various temperatures as well as the length distribution functions. It was found that thermal vibrations shorten considerably the length of chains of correlated collisions. Along the ⟨110⟩ direction, thermal vibrations in the chain itself affect more strongly the length of a chain than do displacements of atoms in neighboring rows. Figures show the length of correlated collision chains as a function of initial energy and the distribution functions for the lengths of correlated collision chains at 0, 273, and 315°K. (A.G.W.)

37597 TEMPERATURE DEPENDENCE OF THE EMISSION OF ELECTRONS BY ION BOMBARDMENT OF ALKALI-HALIDE SINGLE CRYSTALS. Abroyan, I. A.; Aref'eva, I. S.; Lavrov, V. P. (Kalinin Polytechnic Inst., Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 9: 516-18(Aug. 1967).

Translated from Fiz. Tverd. Tela, 9: 667-9(Feb. 1967).

The cleavage surfaces of KCl and KBr single crystals were bombarded by a beam of K ions in a study of the dependence of the electron emission coefficient γ on temperature. It was observed that γ decreased with increase in temperature and that the changes depended on the energy of bombarding particles and on the direction of motion of the particles. Possible explanations of the results are considered. It is concluded that the governing factor is the electron–phonon interaction. (A.G.W.)

37598 X-RAY INDUCED F-CENTERS IN CaF_2. Mukerji, A. (Univ. of Alabama, University); Tanton, G. A.; Williams, J. E. Phys. Status Solidi, 22: K19-22(July 1, 1967).

Production of F centers by irradiating CaF_2 at liquid nitrogen and liquid helium temperatures with 50-keV energy limit x rays is reported. Also, the thermal and optical instabilities of the F centers are discussed. (M.O.W.)

37599 CALCULATION OF THE DEBYE-WALLER FACTOR FOR THE MOESSBAUER EFFECT IN THIN FILMS. Corciovei, A.; Radescu, E. (Institut de Physique Atomique, Bucharest). Rev. Roum. Phys., 12: 177-93(1967). (In French).

The principal aspects of the Moessbauer effect in thin films were considered in order to obtain analytical expressions for the Debye–Waller factor (the fraction of the recoilless emission). By use of the Euler formula for the transformations of a sum into an integral, useful and simple expressions were derived, valid for a zero temperature or a temperature different from zero. (tr-auth)

37600 STUDY OF SIMULTANEOUS REFLECTIONS AND THEIR INFLUENCE ON THE TRANSMISSIBILITY OF ELECTRONS ACCELERATED TO ENERGIES OF BETWEEN 100 AND 1200 KILOVOLTS. Ayroles, Rene; Mazel, Annie (CNRS, Toulouse). J. Microscop., 6: 135-50(1967). (In French).

Absorption of electrons, accelerated up to 1-MeV, by crystals of MgO was studied. At each electron energy level used the crystal was oriented to the beam in a well-defined direction so that the reflections from the crystal lattice could be examined. Microdiffraction patterns from single crystals pasted on a tilting object-holder allowed simultaneous reflections to be observed. They occurred at certain crystal orientations and generally yielded very intense spots. As the accelerating voltage was increased, spots of higher and higher orders appeared and the simultaneous reflections thus became more and more numerous. Extinction distances and mean electron absorption coefficients were determined for voltages between 100 and 200 kV. These experiments showed that simultaneous reflections lead to anomalous values. If there were no such reflections, the results of the measurements were independent of crystal orientation. (BBB)

37601 ANNEALING OF IRRADIATED SILICON CONTAINING PHOSPHORUS ATOMS. Hirata, Masako (Osaka Univ.); Hirata, Mitsuji; Saito, Haruo; Crawford, J. H. Jr. J. Phys. Soc. Jap., 22: 1301(May 1967).

Float zone single crystals of Si doped with phosphorus were irradiated with ^{60}Co gamma rays at room temperature. Isochronal and isothermal annealing studies were made by measurement of minority carrier lifetime. Two stages in the annealing were observed. Activation energy and frequency factor for the second stage were found to be 0.94 eV and 5×10^7 cps respectively. The results fitted a previously established formula relating the activation energy to the atom size of the impurity. (A.G.W.)

37602 GROWTH OF OPTICAL ABSORPTION BANDS IN Ca-DOPED KBr BY X IRRADIATION. Itoh, Noriaki (Princeton Univ., N. J. Osaka Univ.); Ikeya, Motoji. J. Phys. Soc. Jap., 22: 1170-5(May 1967).

Growth of optical absorption bands induced by x irradiation in KBr doped with Ca^{++} was studied at dry ice temperature. It was found that the H–N band (Hayes–Nichols band) saturates and the D_3 band continues to grow linearly as the F band grows. It was also found that the sum of the height of the D_3 band and the height of the H–N band multiplied by a factor of 1.4 is proportional to the height of the F band, suggesting that both centers are complementary defects of the F centers. The saturation concentration of the H–N center was found to be nearly equal to the number of isolated positive ion vacancies obtained from the results of ionic

conductivity measurement. The apparent oscillator strengths of H−N-, D_3- and V_4-centers were also estimated. (auth)

37603 ION-BOMBARDMENT ENHANCED SOLUBILITY IN SOLIDS. Jech, C. (Inst. of Physical Chemistry, Prague). Phys. Status Solidi, 21: 481-6(June 1, 1967).

Two labeling techniques are developed which are based on injection of small concentrations of radioactive atoms with a known concentration profile. These techniques are used for studying enhancement of solubility of mica, Al_2O_3, and NiO induced in these substances by bombardment with Kr ions with energies in the keV region. Mica is found to be the most sensitive, an enhanced solubility of the surface layer being detected for doses as low as 5×10^{12} ions/cm^2. The depth of the soluble layer is found to be comparable with the range of the ions. The effects of ion bombardment on solubility seem to arise from lattice damage resulting from the bombardment rather than from the presence of the injected gas. (auth)

37604 INFLUENCE OF THE SIZE EFFECT ON ELECTRICAL RESISTIVITY MEASUREMENTS IN IRRADIATED METALS. Dworschak, F.; Schuster, H.; Wollenberger, H.; Wurm, J. (Kernforschungsanlage, Juelich, Ger. Technische Hochschule, Aachen). Phys. Status Solidi, 21: 741-5(June 1, 1967).

Two high-purity Al foils of thickness 40 μm and 5.6 μm were simultaneously irradiated. The initial resistivity increments per unit defect concentration for the foils differ by a factor of two because of the size effect. Sondheimer's theory is in good agreement with the experimental data. The calculations are presented for a range of parameters so that the magnitude of this effect can be estimated for other experiments. (auth)

37605 PROPERTIES OF THE LOW-TEMPERATURE INTERNAL FRICTION PEAK IN SILICON. Khiznichenko, L. P.; Kromer, P. F.; Kaipnazarov, D. K.; Otenyazov, E.; Yusupova, D.; Zotova, L. G. (Inst. of Nuclear Physics, Tashkent). Phys. Status Solidi, 21: 805-10(June 1, 1967).

The properties of the low-temperature internal friction peak are studied in n-silicon single crystals at a frequency of 100 Hz at a temperature of approximately 110°K. It is shown that annealing at high temperatures suppresses the peak. Maximum increases after plastic deformation. After γ irradiation the peak height is found to decrease with dose by an exponential law. These features suggest that the peak is of the Bordoni type. Similar internal friction maxima are also observed in n-type germanium and p-type silicon single crystals. (auth)

37606 DETERMINATION OF CHROMIUM DISTRIBUTION IN LASER RUBIES WITH NEUTRON ACTIVATION. Pink, H. (Siemens Aktiengesellschaft, Munich). Phys. Status Solidi, 21: K111-13(June 1, 1967).

Sections of a polished ruby single crystal were irradiated with thermal neutrons for 14 days. Two hundred hours after the end of irradiation, the sections were exposed to photoplates, when they were then developed in the usual manner. Zones of higher and lower chromium concentration were indicated by light and dark sections on the resulting figures. (A.G.W.)

37607 ENERGY DISTRIBUTION OF PHOTOELECTRONS CREATED BY Al K α X RAYS IN ALKALI HALIDE TARGETS. Karras, M.; Suoninen, E. (Univ. of Oulu, Finland). Phys. Status Solidi, 21: 487-93(June 1, 1967).

The spectra of photoelectrons created by aluminum Kα x rays are investigated in CsI, CsF, LiI, and LiF photocathodes. The energy distributions of the photoelectrons are determined by measuring the photoelectric current between two concentric spherical electrodes with a variable retarding potential between them. For a LiF target, the electron spectrum is analyzed quantitatively using an analytical model for the energy distribution of the K photo and K − LL Auger electrons from fluorine atoms. A strong deviation from Whiddington's law is found for the penetration model of the electrons. (auth)

37608 ^{31}P NUCLEAR MAGNETIC RESONANCE IN THE PARAMAGNETIC STATE OF UP. Scott, B. A.; Gingerich, K. A.; Bernheim, R. A. (Pennsylvania State Univ., University Park). Contract AT(30-1)-2541. Phys. Rev., 159: 387-9 (July 10, 1967).

The ^{31}P nuclear magnetic resonance was observed in the paramagnetic stateo f the metallic antiferromagnet, uranium monophosphide (T_N = 123°K). The ^{31}P Knight shift measured over the temperature region 125 to 300°K was found to be positive, varying from K = 2 to 4%. Linearity of the K(T)-versus-χ(T) relationship permitted the assignment of a ^{31}P hyperfine field as +21.6 kOe/(Bohr magneton). Using the Mott−Goodenough theory, the magnetic and electrical properties of UP are interpreted from a model in which the Fermi level lies in overlapping bands composed of phosphorus s, p states and metal 6d-t_{2g} states. (auth)

37609 PRESSURE DEPENDENCE OF THE MAGNETIC TRANSITION TEMPERATURES IN TERBIUM FROM RESISTANCE MEASUREMENTS. Wazzan, Ahmed Rassem; Vitt, R. S.; Robinson, Lawrence Baylor (Univ. of California, Los Angeles). Phys. Rev., 159: 400-8(July 10, 1967).

The pressure coefficients of the Curie and Néel temperatures, T_{cf} and T_N, are determined using electrical-resistance R measurements. The resistance of polycrystalline terbium at constant pressure is determined over the temperature range 200 to 400°K. Pressures to 14.22 kbar are employed. Resistance measurements were made using the standard four-probe method. The Curie and Néel temperatures are determined from (1) plots of R versus T and (2) plots of dR/dT versus T. The values of T_{cf} and T_N thus obtained agree to within ±1°K. The pressure coefficient of the Néel temperature is found to be −1.05°K/kbar; while the coefficient for the ferromagnetic Curie point is determined at −1.24°K/kbar. The variation of the ratio of the Néel temperature to the de Gennes factor, $T_N(g-1)^2J(J+1)$, with pressure is discussed in terms of the variation of the shape of the Brillouin zone, the number of energy states per atom, and the density of states per energy level in the zone with pressure which is directly related to the variation of the c/a ratio with pressure. (auth)

37610 MAGNETIC TRANSITIONS IN ALLOYS OF GADOLINIUM AND DYSPROSIUM. Milstein, Frederick; Robinson, Lawrence Baylor (Univ. of California, Los Angeles). Phys. Rev., 159: 466-72(July 10, 1967).

Magnetic properties of alloys of gadolinium and dysprosium were studied experimentally. As the temperature is lowered, pure gadolinium makes a transition from the paramagnetic state directly to the ferromagnetic state. Pure dysprosium transforms under somewhat similar circumstances from the randomly oriented spin structure to an ordered spin state, commonly referred to as a spiral structure. As the temperature is lowered further, this nonferromagnetic spiral structure changes to the parallel aligned spin structure, which is ferromagnetic. The transition temperatures were investigated as a function of composition of the alloys and also as a function of the ambient pressure. The strength of the internal magnetic interaction evidently depends strongly on interatomic spacings, which are pressure-dependent. The present experiments show that the binary alloys transform directly from the paramagnetic state to the ferromagnetic state when they contain less than ~50 dysprosium. The dysprosium-rich alloys evidently pass through the oscillatory spin state before they become ferromagnetic. Results at atmospheric pressure are consistent with previously reported experiments by others. As the ambient pressure is increased, significant changes occur in the temperatures at which the magnetic transitions occur. In most of the cases, both the Néel temperature (random to spiral structure) and the Curie temperature (parallel aligned structure) decrease with increasing pressure. However, in some cases the Curie temperature appears to increase with increasing pressure. The results are discussed in terms of the Ruderman−Kittel−Kasuya−Yosida model. (auth)

37611 SIGNIFICANCE OF THE LATTICE CONTRIBUTION TO MOESSBAUER QUADRUPOLE SPLITTING: RE-EVALUATION OF THE ^{57m}Fe NUCLEAR QUADRUPOLE MOMENT. Nozik, Arthur J.; Kaplan, Morton (Yale Univ., New Haven). Phys. Rev., 159: 273-6(July 10, 1967).

The lattice contribution to the electric-field gradient at the ^{57}Fe nucleus was considered in detail in several ferrous compounds. Using x-ray crystallographic data and a high-speed computer, direct lattice-sum calculations have been carried out for $FeSiF_6 \cdot 6H_2O$, $FeSO_4 \cdot 7H_2O$, $FeCl_2 \cdot 4H_2O$, and $FeCl_2 \cdot 2H_2O$, yielding the magnitudes and signs of the lattice effect in these compounds. The results obtained ranged from negligible to substantial levels, in terms of the lattice contribution to the observed Mössbauer quadrupole splitting. Of particular importance is the inconsistency between these results and the analytic treatment given by Ingalls, which would predict a much larger lattice contribution with a sign opposite to that of the local electronic field gradient. On the other hand, it is found that one cannot, in general, assume the effect of the lattice to be small, as has frequently been done. Using the computed lattice contribution to the electric-field gradient in $FeSiF_6 \cdot 6H_2O$, and the experimentally measured low-temperature quadrupole splitting in this crystal, the nuclear quadrupole moment of the 14.4-keV state in ^{57}Fe was re-evaluated to be +0.20 b. (auth)

37612 CRITICAL ANGLES FOR CHANNELING OF 1- TO 25-keV H^+, D^+, AND He^+ IONS IN GOLD CRYSTALS. Andreen, C. J.; Hines, R. L. (Northwestern Univ., Evanston, Ill.). Phys. Rev., 159: 285-90(July 10, 1967).

The critical angle for channeling in the low-energy region is measured for H^+, D^+, and He^+ ions transmitted through single-crystal gold foils. It is found that the theoretical calculation by

Lindhard fits the experimental points within the experimental errors if the constant C is given the value 2.15. No difference is found between H^+ and D^+ ions. The critical angle for He^+ ions is found to be 1.13 ± 0.04 times larger than for D^+ or H^+ ions of the same energy. (auth)

37613 ISOTOPIC SHIFT IN THE ELECTRON-SPIN-RESONANCE ABSORPTION SPECTRUM OF Gd^{3+} IN THORIUM OXIDE. Marshall, S. A. (Argonne National Lab., Ill.). Phys. Rev., 159: 191-5(July 10, 1967).

The fine-structure spectrum of trivalent gadolinium occurring as a cation substitution in thorium oxide has been reinvestigated to determine whether this crystal-ion system exhibits fine-structure splittings which are dependent upon isotopic species. Such a dependence has been observed; however, the magnitude of the effect is found to be just within the limits of detectability. For this crystal-ion system, three spin-Hamiltonian parameters are found to be sufficient to characterize the fine-structure spectrum, an isotopic g value, and two crystal-field-splitting energy parameters, b_4 and b_6. At 77°K the relative shift in b_4 between ^{156}Gd and ^{157}Gd is $\delta b_4/b_4 = 4.2 \times 10^{-5}$, the value of b_4 associated with the heavier isotope being greater in magnitude. No shifts in the g value or in b_6 could be detected. When differences in the fine-structure parameter b_4 are measured using the average spectral component positions due to the I = 0 isotopes as references, shifts for ^{156}Gd and ^{157}Gd are obtained which follow a simple mass-difference-ratio relationship. (auth)

37614 STUDIES OF QUADRUPOLE INTERACTIONS BY MEANS OF ANGULAR CORRELATIONS. Andrade, P. da R.; Maciel, Alice; Rogers, J. D. (Univ. Federal do Rio Grande do Sul, Porto Alegre, Brazil). Phys. Rev., 159: 196-200 (July 10, 1967).

Measurements of the nuclear quadrupole interaction were made for the first $\frac{5}{2}^+$ excited state of ^{181}Ta in several compounds of Hf, and for the first $\frac{5}{2}^+$ excited state of ^{111}Cd in In metal by time-differential and by integral-combined-field angular-correlation studies. Interaction frequencies derived from the two measurements are in reasonable agreement and demonstrate the static nature of the interactions involved. Quadrupole-interaction frequencies in 10^6 rad/sec were determined as $\omega_E^0 = 6\ \omega_L = (324 \pm 20)$, (≥600), (≥600) for ^{181}Ta in metallic Hf, $HfOCl_2 \cdot 8H_2O$, and HfO_2, respectively, and (39 ± 10) for ^{111}Cd in In metal by combined interaction measurements. A fundamental frequency of $\omega_L^0 = (680 \pm 80)$ for ^{181}Ta in $HfOCl_2 \cdot 8H_2O$ was determined by a differential measurement. Limitations and possibilities of the two techniques are discussed. (auth)

37615 DETERIORATION DEPTH IN ZnS:Ag UNDER PROLONGED BOMBARDMENT BY HEAVY IONS. van Wijngaarden, A.; Hastings, L. (Univ. of Windsor, Ont.). Can. J. Phys., 45: 2239-48(July 1967).

Local regions on a ZnS:Ag phosphor sample were bombarded by a large number (~10^{14} per cm^2) of heavy ions. This irradiation damaged the phosphor to various depths which depended on the energy of the deteriorating ions. These depths were determined by measuring the energy loss of energetic hydrogen projectiles as they passed through the damaged phosphor regions. It was found that the deterioration depths increase approximately as the square root of the incident energy and for the heavier projectiles (^{40}Ar and ^{84}Kr) these depths are about an order of magnitude larger than the corresponding ranges predicted by the Lindhard theory. No direct correlation, however, between the deterioration depth and the range of the heavier ions is implied. (auth)

37616 ENERGY LOSS OF HEAVY IONS IN ZnS:Ag IN THE keV ENERGY RANGE. Hastings, L.; Ryall, P. R.; van Wijngaarden, A. (Univ. of Windsor, Ont.). Can. J. Phys., 45: 2333-42(July 1967).

Local spots on the surface of ZnS:Ag phosphor samples were deteriorated by a large number (~5×10^{13} ions per cm^2) of low-energy ions. In this manner thin films which did not luminesce under ion bombardment were prepared. These phosphor samples were scanned across energetic ion beams with sufficient energy to traverse the thin phosphor films. By comparing the luminescent response to this ion excitation in the damaged and undamaged portions of the phosphor surface the total average energy losses of ^1H, ^4He, ^{14}N, ^{40}Ar, and ^{84}Kr, in passing through the films, were determined. It was found that the energy losses for the heavier projectiles, when compared with the energy loss for hydrogen, are appreciably smaller than those predicted by the Lindhard and Scharff theory. (auth)

37617 SLOW NEUTRON SCATTERING ON $Ca_2Sr(CH_3CH_2COO)_6$. Dimic, V.; Osredkar, M.; Petkovsek, J. (Jozef Stefan Nuclear Inst., Ljubljana, Yugoslavia). Phys. Lett., 25A: 123-4(July 31, 1967).

The results obtained show that the torsional frequency of the CH_3 group in CaSr-propionate is 100 cm^{-1} above and below the phase transition. Broadening of the quasi-elastic peak indicates a mean lifetime $\tau = 1.9 \times 10^{-12}$ sec of the CH_3 protons at a given site. (auth)

37618 PHOSPHORUS NMR IN THE PARAMAGNETIC STATE OF U_3P_4. Jones, E. D. (Sandia Lab., Albuquerque, N. Mex.). Phys. Lett., 25A: 111-12(July 31, 1967).

The phosphorus Knight shift was measured as a function of temperature in the paramagnetic state of the actinide intermetallic compound U_3P_4. An interpretation of the Knight shift data yields information regarding the signs and magnitudes of the s-f exchange energy and the crystalline field interaction. (auth)

37619 SCATTERING OF PHONONS AT LOW TEMPERATURE IN IRRADIATED SILICON. Vandevyver, M.; Albany, H. J. (CEN, Saclay, Gif-sur-Yvette, France). Phys. Lett., 25A: 115-17(July 31, 1967). (In French).

Phonon scattering by 4-MeV electron-induced defects in silicon is shown to follow a Rayleigh-type law ($\tau^{-1} \sim \omega^4$). (auth)

37620 RADIATION DAMAGE IN THIN METAL FILMS AT 4.2°K. Merkle, K. L.; Singer, L. R. (Argonne National Lab., Ill.). Appl. Phys. Lett., 11: 35-7(July 15, 1967).

The changes in electrical resistance in thin films of gold, copper, and aluminum upon irradiation with heavy charged particles were studied. As a function of dose, there is a steady increase in resistance and a monotonic decrease in the damage rate. A large part of the initial decrease is due to the size effect; however, at higher defect densities the thin film damage rate approaches bulk values. (auth)

37621 DETECTION OF RESISTIVITY VARIATION IN A SEMICONDUCTOR PELLET WITH AN ELECTRON BEAM. Munakata, C. (Hitachi Ltd., Tokyo). Microelectron. Rel., 6: 27-33(Feb. 1967).

The effect of 20-keV electron bombardment on resistivity variation in an n-type Ge pellet whose thickness, width, and length were 0.5, 1, and 1.9 mm was studied. The focused electron beam had a dia less than 30 μ. A periodic resistivity variation of about 240-μ pitch was detected successfully within 20 sec. The resistivity was considered to be between 1 and 3 Ω-cm. The beam current was 2.5 nA. According to the theoretical estimation, the resultant curve is reliable over the region of 90% of the whole curve since an average diffusion length for holes is less than $\frac{1}{10}$ of the specimen length. Position dependency of the diffusion length was a cause of error. The effect of secondary and reflected electrons on the error is negligible at the electron energy of 20 keV. (BBB)

37622 INVESTIGATION OF THE NATURE OF RADIATION-CATALYTIC PROCESSES ON ZEOLITES. Breslav, Yu. A.; Kotov, A. G.; Pshezhetskii, S. Ya. (Inst. of Physics and Chemistry, Moscow). Dokl. Akad. Nauk SSSR, 172: 379-82(Jan. 11, 1967). (In Russian).

A zone model of the solid and a model of active radiation catalysis was proposed on the basis of studies on the decomposition of ammonia adsorbed on zeolites. In order to determine the energy transfer mechanism from the solid sorbent, γ-radiation generated paramagnetic centers of type A synthetic zeolites were investigated. The molecular sieve specimens were pumped out to a residual pressure of 10^{-4} to 10^{-5} mm of Hg for 12 hours, while soaking them at 320 to 350°C, desorbing the water completely. The specimens were irradiated by a ^{60}Co source at a dose rate of 400 to 2000 R/sec at liquid nitrogen temperature. Study of the electron paramagnetic resonance spectra revealed that paramagnetic centers were formed, involving 25 to 37.5 gauss wide singlets in the alkaline zeolites. In the alkaline-earth compounds, narrow, 3.5 to 7.5 gauss wide singlets were noted. It was concluded from the results that the paramagnetic centers formed under the influence of the γ radiation on zeolites of the first group are V centers; in the corresponding alkaline-earth zeolites, F centers are formed. (TTT)

37623 NUCLEAR MAGNETIC RELAXATION IN THE TRANSITION METALS SCANDIUM, YTTRIUM, LANTHANUM, AND YTTRIUM DIHYDRIDE. Narath, A.; Fromhold, T. Jr. (Sandia Lab., Albuquerque, N. Mex.). Phys. Lett., 25A: 49-50(July 17, 1967).

Nuclear spin-lattice and spin-spin relaxation times of ^{45}Sc, ^{89}Y, and ^{139}La have been measured in the temperature range 1 to 4°K in the respective hexagonal metals Sc, Y, and La, and in the cubic intermetallic compound YH_2. (auth)

Theoretical Physics

Refer also to abstracts 37732, 37913, and 38826.

37624 (AD-649818) AXIOMATIC FOUNDATION FOR CONTINUUM THERMODYNAMICS. Gurtin, Morton E.; Williams, William O. (Carnegie Inst. of Tech., Pittsburgh, Pa. Dept. of Mathematics). Jan. 1967. Contract N00014-67A-0314-0001. 70p. CFSTI.

A complete set of axioms is presented, based upon physically acceptable gross forms of the laws of thermodynamics, which yield appropriate forms of these laws for continuum physics; and conditions are found under which these reduce to the classical forms. (STAR)

37625 (JINR-P2-3371) OB URAVNENIYAKH DLYA AMPLITUD RASSEYANIYA V KVANTOVO-MEKHANICHESKOI ZADACHE TREKH CHASTITS. (On the Equations for Scattering Amplitudes in the Quantum Mechanics Three-Body Problem). Khelashvili, A. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 17p. (In Russian). Dep.

A new determination of the transition operators in a three-body system is given. For these operators equations are obtained which do not contain explicitly two-body potentials and the kernels of these equations coincide with those of the Faddeev equations. New equations allow to obtain a set of one-dimensional integral equations of the Lippmann–Schwinger type for the amplitudes of a wide class of three-particle processes. (auth)

37626 (UCID-15180) CONSTANTS OF MOTION OF A NEUTRAL SYSTEM OF CHARGES IN A STATIC, HOMOGENEOUS MAGNETIC FIELD. Carter, Ben (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 15, 1967. Contract W-7405-eng-48. 7p. Dep. CFSTI.

The nonrelativistic, quantum mechanical motion of a system of N particles in an external magnetic field $\vec{B}$ is considered. The field is assumed to be homogeneous and static. It can be stated that $\vec{B} = \nabla \times \vec{A}(\vec{r})$, indicating that the vector potential $\vec{A}$ depends on position ($\vec{r}$) but not on time. If it is assumed that the charges e_i of the particles add up to zero, then $\Sigma_{i=1}^{N} e_i = 0$. The masses m_i are arbitrary. The purpose is to derive constants of motion, by which is meant operators that commute with each other and with the Hamiltonian of the system. No assumptions are made concerning the state of the system. It could be an atom, molecule, solid, liquid, gas, or plasma. (W.D.M.)

37627 NEW FORMULATION OF PARTICLE MECHANICS. Prosser, Reese T. (Massachusetts Inst. of Tech., Cambridge). Mem. Amer. Math. Soc., No. 61, 1-57(1966).

It is suggested that there must be an abstract formulation of the concept of a mechanical system which contains both the classical and quantum formulations as special cases. The description of such a structure would clarify the relations between the two and illuminate the role of the correspondence principle in passing from one to the other. An attempt is made to provide such an abstract formulation and to derive its most elementary properties. The common features of classical and quantum mechanics which are relevant to this purpose are reviewed and the topic is considered in terms of abstract mechanics, structure of moment algebra, representations of the moment algebra, extensions of the moment algebra, dynamical aspects, statistical aspects, and constraints. (W.D.M.)

37628 A NEW PROOF OF VON NEUMANN'S THEOREM CONCERNING THE UNIQUENESS OF THE SCHROEDINGER OPERATORS. Straumann, N. (Univ., Zurich). Helv. Phys. Acta, 40: 518-24(1967).

A new proof of von Neumann's theorem is given, which states that the Schroedinger representation of the canonical commutation relations is (up to unitary equivalence) the only one, in the case of a finite number of canonical variables. (auth)

37629 GENERALIZED LOCALIZABILITY. Jauch, J. M.; Piron, C. (Univ. of Geneva). Helv. Phys. Acta, 40: 559-70 (1967).

It is well known that particles of rest mass zero with spin ≠ 0 belonging to an irreducible representation of the Lorentz group do not admit position operators. Yet such particles exist in nature (for instance the neutrino and the photon) and they are localizable in the experimental sense of this term. The mathematical description of localizability is generalized so as to be applicable in cases where the conventional position operator does not exist. The generalization consists in omitting the hypothesis that all observations of position measurements are compatible with one another. Compatibility is maintained only for space domains which do not overlap or for which one is contained inside the other. For the other cases of overlapping domains compatibility cannot be justified on empirical grounds and it can be dropped. The resulting mathematical object is a generalized system of imprimitivities and it is the appropriate concept for the mathematical description of certain localizable systems. A standard method for constructing such systems based on a theorem of Neumark is given. A particle which is localizable in this sense is called weakly localizable. A further weakening of the conditions leads to the notion of nearly localizable systems. In this case there exists no states which localize the particle exactly in a given space domain, but only states which approximate this property to an arbitrary degree of accuracy (in the topology induced by the states). It is verified that particles of mass m = 0 and spin ½ (neutrinos) are nearly localizable. In addition it is verified that the photons are in fact also weakly localizable. (auth)

37630 QUANTUM MECHANICS OF ONE-DIMENSIONAL TWO-PARTICLE MODELS. ELECTRONS INTERACTING IN AN INFINITE SQUARE WELL. Diestler, Dennis J.; McKoy, Vincent (California Inst. of Tech., Pasadena). J. Chem. Phys., 47: 454-67(July 15, 1967).

Solutions of Schrödinger's equation for the system of two particles bound in a one-dimensional infinite square well and repelling each other with a Coulomb force are obtained by the method of finite differences. For the case of a 4.0-au well, the energy levels are shifted above those of the noninteracting-particle model by as much as a factor of 4 although the excitation energies are only about 50% greater. The analytical form of the solutions is also obtained and it is shown that every eigenstate is doubly degenerate due to the "pathological" nature of the one-dimensional Coulomb potential. This degeneracy is verified numerically by the finite-difference method. The properties of the model system are compared with those of the free-electron and hard-sphere models; perturbation and variational treatments are also carried out using the hard-sphere Hamiltonian as a zeroth-order approximation. The lowest several finite-difference eigenvalues converge from below with decreasing mesh size to energies below those of the "best" linear variational function consisting of hard-sphere eigenfunctions The finite-difference solutions in general give expectation values and matrix elements more accurately than do the other approximations. (auth)

37631 MATERIAL SOURCES FOR THE KERR METRIC. Hernandez, Walter C. Jr. (Goddard Inst. for Space Studies, New York). Phys. Rev., 159: 1070-2(July 25, 1967).

The Kerr metric is a vacuum solution of the Einstein field equations which appears to be the field exterior to some axially symmetric, rotating body. A method based on Synge's g method (guess $g_{\mu\nu}$ and calculate $T_{\mu\nu}$) is given for constructing interior solutions which describe rotating, nonperfect-fluid bodies which might serve as sources of the Kerr metric. Finally, an argument is given which indicates that reasonable perfect-fluid-type solutions which might serve as sources of the Kerr metric may not exist. (auth)

37632 PARTICLE FRAMES AND A COMMENT CONCERNING GRAVITATION. Teitler, S. (Univ. of Copenhagen). Phys. Rev., 159: 1073-6(July 25, 1967).

It is shown how Riesz's description of the Lorentz force on a charged particle in a homogeneous electromagnetic field, in terms of the relative motion of local particle frames, may be generalized to include also the spin dynamics described by the Bargmann–Michel–Telegdi equation. In so doing, it is concluded that tangent dynamics (4-acceleration) is an incomplete probe of the relative motion of local particle frames. A generalization of the Riesz idea to the case of gravitational forces, presented in detail elsewhere, is briefly considered in relation to the concepts developed here. (auth)

37633 NEW METHOD FOR THE DETECTION OF LIGHT DEFLECTION BY SOLAR GRAVITY. Shapiro, Irwin I. (Massachusetts Inst. of Tech., Lexington). Science, 157: 806-8(Aug. 18, 1967).

The prediction of Einstein's theory of general relativity that light will be deflected by the Sun may be tested by sending radio waves from the earth to Venus or Mercury when either passes behind the Sun and detecting the echoes with a radar interferometer. (auth)

37634 THEORIES OF QUANTUM PLASMA BY USE OF THE METHOD OF COLLECTIVE VARIABLES. Hetzheim, H. (Univ., Rostock, Ger.). Ann. Phys., 19: 380-9(1967). (In German).

By use of the method of collective variables an expression for the free energy of an N-particle system with far-reaching intermolecular interactions is given. For high temperatures this expression can be developed according to powers of $\hbar$. The free energy was calculated with a term proportional to $\hbar$. (tr-auth)

37635 ELECTROMAGNETIC BEHAVIOUR IN SPACE-TIMES CONFORMAL TO SOME WELL-KNOWN EMPTY SPACE-TIMES. Singh, K. P.; Roy, S. R. (Banaras Hindu Univ., India). Proc. Nat. Inst., Sci. India, Pt. A, 32: 223-38(May 1966).

Space-times of vanishing scalar curvature $\bar{R}$ conformal to empty spaces are considered. The solutions of the equation $\bar{R}$ =

0, which is a necessary condition for the field to be electromagnetic, are discussed in two stages. In a particular case it is shown that the conformal space–time is null electromagnetic if a certain vector associated with it is null and the empty space is self-conjugate or flat. When the vector is time-like the conformal space is one of disordered radiation and the empty space is necessarily flat. The general solution is discussed for some well-known empty fields including flat space. It is shown that electromagnetic fields exist when the empty space is either flat or one of plane gravitational wave. It is further found that space–times conformal to empty spaces of spherical, cylindrical and static axial symmetries do not represent electromagnetic fields when the corresponding symmetry is preserved. An interesting feature emerging from these solutions is that the square root of the conformal factor propagates with fundamental velocity. (auth)

37636 AN EXACT SOLUTION FOR UNIFORMLY ACCELERATED PARTICLES IN GENERAL RELATIVITY. II. Bonnor, W. B. (Queen Elizabeth Coll., London). Wiss. Z. Friedrich-Schiller-Univ. Jena, Math.-Naturwiss. Reihe, 15: 71-5(1966).

An exact solution of Einstein's equations corresponding to a number of uniformly accelerated particles is given, and the relation of this to static axially symmetric metrics of the Weyl class is investigated. A study of the question whether the world line of a free particle is a geodesic in the test-particle limit showed that this is so for cases in which constrained particles are also present, but not if all the particles are freely moving. The results are relevant to the findings of Infeld and Schild, who showed by a limiting process, that the world line of a test particle is a geodesic. Their procedure is valid only when there is a background field independent of the particle whose mass is made to tend to zero. Such a background does not necessarily exist when all particles are moving freely. An alternative approach to the question of geodesic motion, infinities from world lines, are subtracted by means of modified Infeld delta functions. This would produce a different metric from that found, namely one in which singularities had been removed by Infeld's formalism. It would then be possible to ascertain whether the world line of a free particle is a geodesic in this revised metric. The delta functions required for this procedure would, however, be different from either the Dirac or the Infeld delta functions. (BBB)

37637 VARIATIONAL PRINCIPLE FOR THE SCHRODINGER EQUATION. Ainola, L. (Inst. of Cybernetics, Tallin). Izv. Akad. Nauk Est. SSR, Fiz. Mat., 16: 139-42(1967). (In Russian).

A functional which has as necessary conditions of stationarity the time-dependent Schrödinger equation and corresponding initial and boundary conditions, is presented. As an example of application of the variational principle, the reciprocity theorem in quantum mechanics is derived. (auth)

37638 SUPERRELATIVISTIC THEOREMS. Popovici, Andrei. Stud. Cercet. Mat., 18: 1471-1509(1966). (In Rumanian).

On the basis of Cayley projective metrics of the relativistic space involving Lobachevskii-type velocities, the invariance of the Einstein velocity composition laws with respect to the replacement of the velocities with "reciprocal velocities," was demonstrated, showing that the squares of the absolute spatial, temporal and cosmic, direct and indirect values constitute a projective group. The elementary particles are classified on the basis of the sign of the relativistic interval into two rest masses, indicating the existence of two types of particles for a given spin and isospin, moving with the speed of light. Transition from velocities lower to those higher than the velocity of light (or in the inverse direction), is equivalent with the permutation of cosmic or specific variables. It implies a change in the nature of the particle, i.e., of the isofermionic number, and a permutation of the corpuscular and phase velocities. Thus, the irreversibility of time and causability is conserved. The theorems valid for velocities beyond the speed of light include interactions (forces, fields) higher than the "maximum interaction," representing the correspondence between the theory of relativity and that of reciprocity, specifically the correspondence between the fusion of isofermionic and leptonic states and the isospin and spin states. (TTT)

37639 CONJECTURE REGARDING QUANTIZED GRAVITATIONAL THEORY AND THE SIZE OF ELEMENTARY PARTICLES. Rosen, Gerald (Drexel Inst. of Tech., Philadelphia). Can. J. Phys., 45: 2383-4(July 1967).

For the quantum theory of general relativity in the real physical universe with radius of about 10^{28} cm, the order-of-magnitude analysis in this work leads to a fundamental and characteristic metrical disturbance, with a size of about 10^{-12} cm. It is possible that such a characteristic metrical disturbance (and the considerable amount of associated gravitational energy) may play an important role in elementary particle structure. (auth)

37640 SIGN OF THE GRAVITATIONAL FORCE. Deser, S. (Brandeis Univ., Waltham, Mass.); Pirani, F. A. E. Ann. Phys. (N. Y.), 43: 436-51(July 1967).

The theoretical assumptions determining the sign of the static long-range ("Newtonian") force between particles in general relativity, and in a number of other theories, are identified. It is first shown that in a Lorentz-covariant theory of a massless field, the sign of the Newtonian force is determined by the spin of the field and by the requirement, essential for quantization, that the field energy be positive. Without this requirement, the sign may be fixed arbitrarily, as is the case in direct action theories where no corresponding criterion exists. Despite unavoidable complications, which are discussed in some detail, the situation in general relativity theory is similar to that in Lorentz-covariant theories. However, the interaction between gravitational geons (self-maintaining purely gravitational excitations) is exceptional, in that its sign is completely determinate, without ancillary assumption. The geon–geon and geon–particle interactions are discussed at length; in the latter, the effect of the geon on the particle is also completely determinate, while the effect of the particle on the geon may be chosen arbitrarily. These results are related to the fact that a geon has no independently defined inertial mass, since its interactions are purely gravitational. The arguments which show that the gravitational interactions of matter and of anti-matter must be the same are also reviewed briefly. Some alternatives to Einstein theory, in which the positive energy requirement is inapplicable, and the sign of the Newtonian force is fixed by enlarging the invariance group of the theory, are discussed. (auth)

37641 SELF-ENERGY CONSIDERATIONS IN GENERAL RELATIVITY AND THE EXACT FIELDS OF CHARGE AND MASS DISTRIBUTIONS. Kyle, C. F.; Martin, A. W. (Stanford Univ., Calif.). Nuovo Cim. (10), 50A: 583-604(Aug. 1, 1967).

Exact solutions of the field equations of general relativity are obtained for the case of static and spherically symmetric distributions of mass and charge, providing interior solutions for the continuation of the Reissner–Nordström metric to the origin. In the limit in which the charge density vanishes the solutions reduce to the familiar interior Schwarzschild solution and a more general interior solution found by Tolman. The exact solutions permit the computation of the self-energy contributions to the total gravitational mass, in particular those contributions due to the effect of the charge upon the metric. The results are presented in terms of a power series expansion in the gravitational constant. The possible singularities of the metric are discussed and the self-energy analysis is applied to a classical model of the pion to illustrate the magnitude of the gravitational effects in a familiar example. (auth)

37642 HAMILTONIAN FORM OF THE KEMMER EQUATION. Zeleny, W. B. (Naval Postgraduate School, Monterey, Calif.). Phys. Rev., 158: 1223-6(June 25, 1967).

The Hamiltonian form of the relativistic wave equation for bosons of spin 0 or 1 was first given by Kemmer. The problems associated with the redundant components of the wave function were later resolved by Heitler, who eliminated the redundant components by means of projection operators. An alternative treatment is presented which yields essentially the same results as obtained by Heitler, but which retains all components of the wave function. (auth)

37643 OBSERVABILITY OF THE SIGN CHANGE OF SPINORS UNDER 2π ROTATIONS. Aharonov, Yakir; Susskind, Leonard (Yeshiva Univ., New York). Phys. Rev., 158: 1237-8(June 25, 1967).

The observability of the sign change of spinors under 2π rotations is considered. It is shown that in certain circumstances there are observable consequences of such rotations, contrary to the classical case. Experiments which can in principle be done to demonstrate such effects are suggested. (auth)

37644 GRAVITATIONAL BREMSSTRAHLUNG IN NONRELATIVISTIC COLLISIONS. Carmeli, Moshe (Univ. of Maryland, College Park). Phys. Rev., 158: 1243-8(June 25, 1967).

The spectral resolution of the low-frequency gravitational radiation emitted by a system of colliding particles is found. This is done by applying Fourier analysis to Landau and Lifshitz's formula for the gravitational radiation intensity. The result is in accord with that recently obtained by Weinberg through quantum-gravidynamical methods, which predicts 6×10^{44} erg/sec for the solar gravitational radiation power. The total gravitational radiation of the same scattering process is then found for all frequencies and without resolution into a Fourier integral. The calculation is free from any cutoff process which is needed for the low-frequency power, and the result is one order of magnitude larger than the low-frequency power when applied to the solar system. (auth)

37645 UNIQUENESS OF THE RELATIVISTIC ENERGY-MOMENTUM TENSOR IN POLARIZED MEDIA. de Groot, S. R.; Suttorp, L. G. (Univ. of Amsterdam). Phys. Lett., 25A: 103-4 (July 31, 1967).

The energy-momentum tensor in a polarized medium, as derived from microscopic theory, can be looked upon as the sum of a material part, defined at zero field, and a field part. It can then be shown that both Minkowski's and Abraham's tensors are unjustifiable. (auth)

37646 THE GOLDSTONE THEOREM AND THE JAHN-TELLER EFFECT. Sarfatt, J. (Univ. of California, La Jolla); Stoneham, A. M. Proc. Phys. Soc. (London), 91: 214-21(May 1967).

The Goldstone theorem [Lange, Phys. Rev., 146: 301-3(1966)] requires that a many-body system with broken symmetry has an excitation branch whose frequency tends to zero in the limit of infinite wavelength. A system is considered where the broken symmetry comes from the terms which give rise to the Jahn-Teller effect. Both the excitation branches discussed have finite frequencies at infinite wavelength when there is no Jahn-Teller term; the introduction of this term forces one branch to have zero frequency at infinite wavelength, in agreement with the Goldstone theorem. The main point of this paper is this striking illustration of Goldstone's conjecture. Some of the simpler features of the excitation branches are discussed (they do not appear to have been treated in detail in the literature). Systems of ions in twofold degenerate E ground states may exhibit such excitations, which will have a characteristic velocity considerably less than that of sound. (auth) (UK)

37647 RELATIVISTIC EQUATIONS OF STATE. Geroch, R. P.; Hegyi, D. J. (Palmer Physical Lab., Princeton, N. J.). Nature (London), 215: 501(July 29, 1967).

A new approach is offered to the question of given a material medium with its equation of state, what conditions must be satisfied by that equation of state if the existence of such matter is to be consistent with the principles of special relativity. The approach has the advantage that it is not necessary to consider the detailed structure of the matter, but it has the disadvantage that it is not applicable, in its present form, to nuclear matter at high densities. The approach is illustrated by a simple example based on a spring, taking into account the following parameters: unstressed length, mass per unit length, and spring constant x length. Energy conservation and causality are assumed. (UK)

37648 WEAKENED FIELD EQUATIONS IN GENERAL RELATIVITY ADMITTING AN "UNPHYSICAL" METRIC. Lovelock, D. (Univ. of South Africa, Pretoria). Commun. Math. Phys., 5: 205-14(1967).

Certain weakened vacuum field equations which have been suggested as alternatives to the vacuum field equations of general relativity are investigated. It is shown that they each possess a solution which corresponds to an isolated mass at the origin which repels test particles. In view of the contradiction with experiment this solution is an embarrassment to those proposed vacuum field equations. (auth)

37649 METHODS IN THE QUANTUM THEORY OF MAGNETISM. Tyablikov, Sergei Vladimirovich. New York, Plenum Press, 1967. 366p. $13.50.

Translated by Albin Tybulewicz from Metody Kvantovoi Teorii Magnetizma.

Topics discussed in this presentation of some fundamentals of the quantum theory of magnetism include the second quantization method, the problem of spin Hamiltonians in the theory of strong magnetism, statistical mechanics, the approximate second quantization (spin wave) method, the molecular field method, elements of the perturbation theory at high temperatures, and the method of Green's quantum functions. Also covered are the Heisenberg model, degeneracy of states, isotropic ferromagnets and ferrimagnets, resonance, and scattering problems. (A.G.W.)

37650 SOURCES OF QUANTUM MECHANICS. Van Der Waerden, B. L. (ed.). Amsterdam, North-Holland Publishing Co., 1967. 438p. Hfl. 50.--.

The works leading up to the establishment of quantum mechanics and the papers which stated the fundamentals of quantum and matrix mechanics are presented. The two groups of papers are preceded by a historical introduction. (M.O.W.)

37651 STUDIES IN THE FOUNDATIONS METHODOLOGY AND PHILOSOPHY OF SCIENCE. VOLUME 2. QUANTUM THEORY AND REALITY. Bunge, Mario (ed.). New York, Springer-Verlag New York Inc., 1967. 121p. $7.40.

Scientific and philosophical discussions of quantum mechanics are given. The main topics are: the epistemological issue; ψ, measurement, and the new particle crop; and the objectivistic foundations of quantum mechanics. (M.O.W.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 37973.

37652 (NP–16933) REPORT ON RECENT EXPERIMENTAL DATA, 1966. Report No. 50. Venkatesan, K. (Institute of Mathematical Science, Madras (India)). 156p. Dep.

A collection of monthly reports issued during 1966 of recent experimental data on elementary particles is presented. The general trend is toward the study of strong interactions at higher and higher energies. An index is also included, which is divided according to strong interactions, resonances, electromagnetic interactions, and weak interactions. (L.B.S.)

37653 (UCLA–34P106-1) ANNUAL PROGRESS REPORT [ON PARTICLE PHYSICS], MAY 10, 1966–MAY 24, 1967. (California Univ., Los Angeles. Dept. of Physics). Contract AT(11-1)-34. 29p. Dep. CFSTI.

Work performed by the UCLA particle physics group from May 10, 1966 to the present is reported. The major effort during the preceding year has been spent on three separate experiments. At the time of the 1966 report the K_2^0 ($\mu 3$) polarization experiment was in a background study stage. This experiment was completed during the summer. The second effort was a second data run on the ln γ experiment to supplement information obtained in the preceding year. Data taking was terminated in the fall, followed by extensive work to measure the absolute efficiency of our neutron counters in the neutron beam at the LRL 184″ cyclotron and to measure the absolute efficiency of the γ-ray counters using the γ-ray monochromator at Cal Tech's synchrotron. Thirdly, a new experiment has been prepared and data taking will begin about June 15. The experiment is a study of the differential cross section of the reaction $n + p \rightarrow \gamma + d$. This reaction, in conjunction with its inverse reaction, constitutes a direct test of time reversal invariance in photo-meson reactions. A collaboration including the University of Michigan and the Moyer group at LRL was formed to carry out this project. Work on the analysis of data taken in preceding years has been continued. This includes work on K^+ decay experiment, $2n\gamma$ experiment, and K_2^0 decay experiments. Investigation of proton polarization in frozen toluene and other hydrocarbons has been continued. And finally, the design of an experiment to measure the electromagnetic form factor of the π^0 meson has been pursued. These experiments are discussed in detail. Chapter III is devoted to equipment constructed in the past year, Chapter IV contains a bibliography of published work and reports. (auth)

Electromagnetic

Refer also to abstract 36456.

37654 (BMwF-FBK–67-52) EINE UNTERSUCHUNG UEBER DEN ZERFALL DES NEUTRALEN PI-MESONS IN DREI GAMMA-QUANTEN. (A Search for the Three Gamma Decay of the Neutral Pion). Rieseberg, H. (Heidelberg Univ. (West Germany). Physikalisches Institut (I)). June 1967. 13p. (In German). Dep.

A counter experiment is described to search for the decay $\pi^0 \rightarrow 3\gamma$. The existence of this decay mode would indicate the noninvariance of strong or electromagnetic interactions under charge conjugation. The π^0's were produced in the reaction π^- at rest + $p \rightarrow \pi^0 + n$ by stopping negative pions in a liquid hydrogen target. The γ-rays were detected in a large NaI crystal and in a cylindrical array of lead glass Čerenkov counters. The experiment yields, with 90% confidence for the branching ratio $R = (\pi^0 \rightarrow 3\gamma)/(\pi^0 \rightarrow 2\gamma)$, the upper limit $R = 5\ (10^{-6})$, a value which is nearly two orders of magnitude smaller than the latest value published. (auth)

37655 (DESY–67/20) SUCHE NACH LEPTONISCHEN QUARKS MIT MASSEN ZWISCHEN 100 UND 900 MeV. (Search for Leptonic Quarks with Masses Between 100 and 900 MeV). Bathow, G.; Freytag, E.; Schulz, H. D.; Tesch, K. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). June 1967. 21p. (In German). Dep.

A search was performed for photoproduced leptonic particles with fractional charges (leptonic quarks). With a 99% statistical significance, none were found with charges $\frac{1}{3}$ and $\frac{2}{3}$ and masses below 850 and 900 MeV. (auth)

37656 (DESY–67/22) SCATTERING OF POSITRONS AND ELECTRONS FROM PROTONS. Bartel, W.; Dudelzak, B.; Krehbiel, H.; McElroy, J. M.; Morrison, R. J.; Schmidt, W.; Walther, V.; Weber, G. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). July 1967. 12p. Dep.

The result of an experiment in which the ratio of the elastic scattering cross section for positrons and electrons on protons was measured at momentum transfers of $q^2 = 11.66$ and $35.1\ f^{-2}$ is reported. This experiment was performed at $q^2 = 35.1\ f^{-2}$. In order to determine a possible q^2-dependence of R, a measurement was also made at $q^2 = 11.66\ f^{-2}$. No indication of a contribution to the cross section of a two-photon amplitude was found. (J.F.P.)

37657 (ORO–3065-13(and App.A)) PROGRESS REPORT [ON PARTICLE PHYSICS], OCTOBER 1, 1966–JULY 1967. Fowler, Earle C. (Duke Univ., Durham, N. C.). July 26, 1967. Contract AT(40-1)-3065. 9p. Dep. CFSTI.

A summary of research on $K^- + p$ interactions near 740 MeV/c in the hydrogen bubble chamber is presented. Included in the interactions studied are resonance production and η production and decay modes. (auth)

37658 LIMIT TO THE ELECTRIC DIPOLE MOMENT OF THE NEUTRON. Miller, P. D. (Oak Ridge National Lab., Tenn.); Dress, W. B.; Baird, J. K.; Ramsey, Norman F. Phys. Rev. Lett., 19: 381-4(Aug. 14, 1967).

A neutron-beam magnetic resonance experiment with very slow neutrons (as low as 60 m/sec) was used to set a limit to the neutron electric dipole moment that is more than 100 times lower than the previous limit set by Smith, Purcell, and Ramsey. The value found for the neutron electric dipole moment divided by the proton charge is $\mu_e/e = (-2 \pm 3) \times 10^{-22}$ cm. This value is lower than the predictions of many of the time-reversal-noninvariant theories which account for the K_2^0 decay. (auth)

37659 ELECTRON INTERFERENCE EFFECTS INDUCED BY LASER LIGHT. Dawson, John F.; Fried, Zoltan (Lowell Technological Inst., Mass.). Phys. Rev. Lett., 19: 467-9(Aug. 21, 1967).

An electron-interference experiment involving laser light is proposed. It is estimated (roughly) that presently available (cw) laser sources can yield detectable "fringe" displacement in the electron interference pattern. (auth)

37660 SEARCH FOR A NEUTRON ELECTRIC DIPOLE MOMENT BY A SCATTERING EXPERIMENT. Shull, C. G. (Massachusetts Inst. of Tech., Cambridge); Nathans, R. Phys. Rev. Lett., 19: 384-6(Aug. 14, 1967).

Results are reported of a polarized-beam scattering experiment, which has yielded a considerable refinement in the possible upper limit for the neutron electric dipole moment. The experiment exploits the fact that a neutron carrying an intrinsic electric dipole moment will experience an extra interaction with the atomic Coulomb field in passing through a scattering atom. A search was made for very small intensity effects upon neutron polarization reversal in a Bragg reflection from CdS crystals. The results yield a dipole length with electronic charges of $D = +(2.4 \pm 3.9) \times 10^{-22}$ cm. (L.B.S.)

37661 π^+ PHOTOPRODUCTION FROM HYDROGEN AT LABORATORY ENERGIES FROM 589 TO 1269 MeV. Ecklund, S. D.; Walker, R. L. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., 159: 1195-1209(July 25, 1967). (CALT-68-110).

The differential cross section for the reaction $\gamma + p \rightarrow \pi^+ + n$ was measured at 32 laboratory photon energies between 589 and 1269 MeV at the Caltech synchrotron. At each energy, data were obtained at typically 15 π^+ angles between 6° and 90° in the center-of-mass (c.m.) system. A magnetic spectrometer was used to detect the π^+ photoproduced in a liquid-hydrogen target. Two Cherenkov counters were used to reject background of positrons and protons. The data clearly show the presence of a pole in the production amplitude due to one-pion exchange. Moravcsik fits to the angular distributions, including data from another experiment carried out by Thiessen, are presented. Extrapolation of these fits to the pole gives a value for the pion-nucleon coupling constant of 14.2 ± 1.7, which is consistent with the accepted value. The "second" and "third" pion nucleon resonances are evident as peaks in the total cross section and as changes in the shape of the angular distributions. At the third resonance, there is evidence for both a $D_{\frac{3}{2}}$ and an $F_{\frac{3}{2}}$ amplitude. The absence of large variations with energy in the 0° and 180° cross sections implies that the second and third resonances are mostly produced from an initial state with helicity $\frac{3}{2}$. (auth)

37662 Λ POLARIZATION AT 90° IN K⁺Λ PHOTOPRODUCTION. Groom, D. E.; Marshall, J. H. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., 159: 1213-19 (July 25, 1967). (CALT-68-112).

The Λ polarization and the differential cross section for the reaction $\gamma + p \rightarrow K^+ + \Lambda$ were measured, using the Caltech synchrotron, at 90° in the c.m. system and at laboratory photon energies of 1100, 1200, and 1300 MeV. Protons from the asymmetric decay of the Λ were detected by counters placed above and below the production plane. Kaons were identified by their behavior in a thick range telescope. Polarization results were $P_\Lambda = +0.34 \pm 0.09$ at 1100 MeV, $+0.30 \pm 0.07$ at 1200 MeV, and $+0.08 \pm 0.07$ at 1300 MeV, where P_Λ was measured in the $\hat{p}_\gamma \times \hat{p}_\Lambda$ direction. The differential cross section was constant with energy at 0.14 ± 0.01 μb/sr. Although the apparent bump in the polarization at 90° at a total energy of ≈1700 MeV adds support to models which invoke a resonance here, no really new conclusions can be reached. (auth)

37663 PHOTOPRODUCTION OF NEUTRAL PIONS FOR INCIDENT PHOTON ENERGIES 400 TO 800 MeV. SEARCH FOR A RESONANT P_{11} STATE AND REMARKS ON THE η CUSP EFFECT. Bacci, C. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Penso, G.; Salvini, G.; Mencuccini, C.; Reale, A.; Silvestrini, V.; Spinetti, M.; Stella, B. Phys. Rev., 159: 1124-37(July 25, 1967).

Cross sections for the photoproduction of neutral pions were measured at the 1.1-GeV Frascati electron synchrotron for bombarding photon energies k between 400 and 800 MeV and for π^0 c.m. angles of $\theta_\pi^* = 90°$, 120°, and 135°. The main feature of the experiment is good resolution in incident photon energy. The results are in good agreement with the existing theories in the energy range of 450 to 550 MeV. The cross sections exhibit a smooth behavior as a function of energy for k = 400 to 600 MeV. No immediate evidence is found of a contribution of the P_{11} resonance. An anomaly at the limit of statistical significance appears for k ≃ 700 to 740 MeV, indicating a possible structure of the so-called second resonance. An attempt is made to interpret the observed anomaly as a reflection of the sharp opening of the η production channel (η cusp effect). (auth)

37664 SEARCH FOR LEPTONIC QUARKS. Foss, J.; Garelick, D.; Homma, S.; Lobar, W.; Osborne, L. S.; Uglum, J. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Lett., 25B: 166-8(Aug. 7, 1967). (MIT-2098-343).

A search for leptonic quarks (non-strongly interacting fractionally charged particles) was performed at the Cambridge electron accelerator. No fractionally charged particles were detected. The following limits on the quark mass were calculated assuming that the Bethe–Heitler pair production cross section describes the production process: Charge $(z_Q) = \frac{1}{3}$: $M_Q \geq 780$ MeV or $M_Q \leq 0.5$ MeV. $\frac{2}{3}$: $M_Q \geq 840$ MeV or $M_Q \leq 2.0$ MeV. (auth)

37665 SEARCH FOR LEPTONIC QUARKS IN THE MASS RANGE 100 TO 900 MeV. Bathow, G.; Freytag, E.; Schulz, D. H.; Tesch, K. (DESY, Hamburg). Phys. Lett., 25B: 163-5 (Aug. 7, 1967).

A search was performed for photoproduced leptonic particles with fractional charges (leptonic quarks). With a 99% statistical significance, none were found with charges $\frac{1}{3}$ and $\frac{2}{3}$ and masses below 850 and 900 MeV. (auth)

37666 NUCLEAR INTERACTIONS PRODUCED IN THE EMULSION CHAMBER. Akashi, M. (Hirosaki Univ., Japan); Watanabe, Z.; Nishimura, J.; (and others). Notas Fis., Cent. Brasil. Pesqui. Fis., 12: No. 14, 229-51(1967).

Large emulsion chamber (6 m^2 in area, 29 cm Pb thick) were exposed at Mt. Chacaltaya (5200 m) for about 10 months with a collaboration of Japanese and Brazilian emulsion groups. Several hundred γ rays incident upon and nuclear events produced in the chamber with energy higher than 2.10^{12} eV were observed and the results are reported. The results of observation at Mt. Norikura (2800 m) carried out by Japanese group are also included. (auth)

37667 PHOTONUCLEAR REACTIONS ABOVE THE MESONIC THRESHOLD GAMMA NEUTRON REACTIONS IN IODINE AT ENERGIES BETWEEN 300 AND 1000 MeV. di Napoli, V. (CNEN, Rome. Univ., Rome); Dobici, F.; Salvetti, F.; de Carvalho, H. G. Notas Fis., Cent. Brasil. Pesqui. Fis., 12: No. 7, 105-27(1966).

The magnitude, energy, and mass number dependence of the photonuclear absorption cross section is studied at energies above the meson production threshold. The (γ,n), (γ,2n) and (γ,3n) cross sections from iodine for photons of energies between 300 and 1000 MeV are reported. It was found that the (γ,n) cross section is unexpectedly high, exceeding in value the total inelastic cross section calculated by the photomeson optical model. (J.F.P.)

37668 TOTAL ABSORPTION MEASUREMENTS OF 100 TO 250 MeV PHOTONS IN HYDROGEN. Brookes, G. R.; Railton, R.; Rutherglen, J. G.; Smith, I. L. (Dept. of Nautral Philosophy, Glasgow). Nucl. Phys., B2: 424-32(1967).

The total cross section for the absorption of photons in hydrogen was measured for photon energies of 100, 150, 200 and 250 MeV. The γ-ray bremsstrahlung beam from the 300-MeV electron synchrotron was used as the source of photons. Two magnetic pair spectrometers were used as photon detectors. From the results, values of the cross section for triplet production were derived which are in better agreement with theoretical calculations based on the predictions of Borsellino than with those of Votruba. (auth)

37669 TRANSITION RADIATION FROM RELATIVISTIC CHARGED PARTICLES AND ITS ENERGY DEPENDENCE. Oostens, J.; Prunster, S.; Wang, C. L.; Yuan, Luke C. L. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 19: 541-3(Aug. 28, 1967). (BNL-11565).

Transition radiation in the optical region of the spectrum from individual charged pions and protons in the momentum region of 0.8 to 3.5 BeV/c was obtained from a stack of thin metal foils spaced uniformly in vacuum. The radiation was observed simultaneously in the forward and in the backward directions, with a forward-to-backward intensity ratio of the order of 8 to 1. A logarithmic increase in the intensity of the transition radiation with the total energy of the particle is found in the momentum region of the present investigation. (auth)

Weak

37670 (NEVIS-158) INVERSE mu CAPTURE WITH GeV NEUTRINOS. Hyman, Emile (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.). Jan. 1967. Contract AT(30-1)-1932. 85p. (R-576; CU-1932-262). Dep. CFSTI.

Thesis.

Photographs of aluminum spark chambers exposed to a multi-BeV neutrino beam were scanned for "elastic" events of the type: $\nu + n \rightarrow \mu^- + p$ and $\bar{\nu} + p \rightarrow \mu^+ + n$. A large and hard-to-estimate contamination is the "inelastic" reaction symbolized by: $\nu + n \rightarrow n' + \mu + \pi$ and π + (remaining Al nucleus) → star. Calculations of the neutrino flux were checked by predicting the associated muon flux. The observed rate of elastic events is consistent with an extension of the theory which described a low energy inverse reaction, mu capture. (auth)

37671 EXPERIMENTAL STUDY OF $K^+ \rightarrow \pi^0 + e^+ + \nu$ DECAY. Kalmus, George E. (Univ. of California, Berkeley); Kernan, Anne. Contract W-7405-eng-48. Phys. Rev., 159: 1187-94(July 25, 1967). (UCRL-17351).

An analysis of 515 decays $K^+ \rightarrow \pi^0 + e^+ + \nu$ in a Freon-filled bubble chamber is described. The events were kinematically overdetermined so that a complete reconstruction of each decay was possible. All decay configurations were detectable except for those with positron momentum less than 5 MeV/c. The data are satisfactorily described by a pure vector interaction. The energy dependence of the vector form factor f_+ is given by $|f_+(q^2)| = |f_+(0)\, M^2/(M^2 - q^2)|$, with $M = 810^{+320}_{-140}$ MeV, or equivalently, $|f_+(q^2)| = |f_+(0)| \times [1 + \lambda(q^2/m_\pi^2)]$, with $\lambda = 0.028^{+0.013}_{-0.008}$. In the Callan-Treiman relation for K_{12} and K_{13} decays, this value of λ leads to the prediction that $\xi = 0.0 \pm 0.1$ or -2.0 ± 0.1. Upper limits for scalar and tensor currents are given. Systematic biases inherent in the heavy-liquid-chamber technique are discussed. (auth)

37672 AN EXPERIMENTAL DETERMINATION OF THE RELATIVE PROBABILITIES FOR VARIOUS BRANCHES OF K_2^0 DECAY. Kulyukina, L. A.; Mestvirishvili, A. N.; Nyagu, D.; Petrov, N. I.; Rusakov, V. A.; U, Tsung-fan (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 53: 29-40(July 1967). (In Russian).

The following relative probabilities for lepton and nonlepton decays were derived from an analysis of 9400 V^0 events due to the decay of long-lived K^0 mesons: $W(K^0_{e3}) = (49.8 \pm 5.2)\%$, $W(K^0_{\mu 3}) = (33.5 \pm 5.5)\%$, $W(K^0_2 \rightarrow \pi^+ + \pi^- + \pi^0) = (16.7 \pm 1.6)\%$, $W(K^0_2 \rightarrow 3\pi^0) = (31^{+7}_{-6})\%$. Within the experimental errors the results are in good agreement with the selection rule $\Delta I = \frac{1}{2}$ for the isotopic spin. (auth)

Strong (Baryon-Induced)

Refer also to abstracts 37701, 37839, 38215, 38234, and 38346.

37673 LOW-ENERGY (Σ^+,p) AND (Σ^-,p) ELASTIC SCATTERING. Rubin, H. A. (Univ. of Maryland, College Park); Burnstein, R. A. Phys. Rev., 159: 1149-56(July 25, 1967).

The cross sections for the elastic scattering of Σ^+ and Σ^- hyperons on protons were measured. The hyperons were produced by the interactions of stopping K^- mesons in a hydrogen bubble chamber. The cross section for (Σ^-,p) elastic scattering is 166 ± 33 mb, at a mean laboratory momentum of 150 MeV/c. The cross

section for (Σ^+,p) elastic scattering is 84 ± 34 mb at a mean laboratory momentum of 161.5 MeV/c. These measurements, as well as the results of similar experiments, are compared with several recent theoretical predictions of hyperon-nucleon scattering cross sections. (auth)

37674 OBSERVATION OF THE INTERACTION $p + d \rightarrow {}^3He + \pi^0$ AT A PROTON ENERGY OF 1.5 GeV. Melissinos, A. C. (Univ. of Rochester, N. Y.); Dahanayake, C. Contract AT(30-1)-875. Phys. Rev., 159: 1210-13(July 25, 1967). (UR-875-180).

Using nuclear emulsions as a detector, the reaction $p + d \rightarrow {}^3He + \pi^0$ was studied at an incident proton energy $T_p = 1.515$ BeV. The differential cross section in the c.m system at 0^0 was found to be $(d\sigma/d\Omega)_{c.m.} = (4.1^{+4}_{-2}) \times 10^{-32}$ cm². (auth)

37675 ELASTIC PROTON–PROTON SCATTERING AT 90^0 AND STRUCTURE WITHIN THE PROTON. Akerlof, C. W. (Univ. of Michigan, Ann Arbor); Hieber, R. H.; Krisch, A. D.; Edwards, K. W.; Ratner, L. G.; Ruddick, K. Phys. Rev., 159: 1138-49(July 25, 1967).

The differential cross section for proton-proton elastic scattering at 90° in the center-of-mass system was measured at laboratory momenta ranging from 5.0 to 13.4 GeV/c. Fifty-one measurements were made at momentum intervals of 100 or 200 MeV/c. The extracted proton beam of the ZGS impinged upon a CH_2 target. The two scattered protons were detected by two spectrometers consisting of magnets and scintillation counter telescopes in coincidence. The incident beam flux was measured by radiochemical analysis of the CH_2 targets. The experiment showed no evidence for any S = 0, T = 1 dibaryon resonances in the 3300 to 5200-MeV mass range. It also yielded some information about the validity of the statistical model and the analyticity of the scattering amplitude. The most interesting result of the experiment was a sharp break in the fixed-angle cross section. This may be evidence for the existence of two inner regions of the proton with radii 0.51 ± .02 and 0.34 ± .02 F. (auth)

37676 MULTIPLE MESON PRODUCTION BY HEAVY PRIMARY NUCLEI OF COSMIC ORIGIN AND THEIR FRAGMENTATION PRODUCTS AT ENERGIES ABOVE 10^{12} eV. Abraham, F. (Univ. of Chicago); Gierula, J.; Levi Setti, R.; Rybicki, K.; Tsao, C. H.; Wolter, W.; Fricken, R. L.; Huggett, R. W. Phys. Rev., 159: 1110-23(July 25, 1967).

Studies were made of the interactions initiated by fragments, including nucleons, from the gradual breakup of ultra high-energy heavy nuclei in a large block of nuclear emulsion. The results obtained by this approach are free from the detection biases that arise in scanning for, e.g., high-energy electromagnetic cascades. For one family of genetically related interactions the primary per-nucleon energy could be reliably established as ~1.3 TeV. The sample of nucleon-induced interactions with average multiplicity $n_s < 25$, with primary energies in the region of 1 TeV, show strong bimodality in the angular distribution of the created particles. An upper limit of 1.5 BeV/c is found for the average transverse momentum of the possible fireballs that could have given rise to this bimodality. The average inelasticity for the same sample of collisions is ~0.6. The average multiplicity n_s for the nucleon-induced interactions with $N_h \leq 5$ is ~11.5. For the interactions initiated by heavy nuclei the lower limit to the average per-nucleon multiplicity, $n_s/\Delta A$, in the energy interval 1 to 20 TeV is consistent with the average multiplicity for the nucleon-induced interactions at about 1 TeV. A linear superposition, in nucleus-nucleus collisions, of elementary nucleon-nucleon acts of meson production is suggested. (auth)

37677 P–P ELASTIC SCATTERING AT 2 BeV. Ijaz, M. A. (Virginia Polytechnic Inst., Blacksburg); Leach, E. R.; Munir, B. A. J. Natur. Sci. Math., 6: 155-68(Oct. 1966).

A 2-GeV proton beam was fired into a hydrogen bubble chamber. About 6000 two-prong events were selected for measurement, and kinematic fits to the interactions $p + p \rightarrow p + p$, $p + p \rightarrow p + n + \pi^+$, and $p + p \rightarrow p + p + \pi^0$ were tried. The missing mass distribution for elastic events and various fits are shown. The elastic total cross section is measured to be 17.47 ± 0.71 mb. The differential cross section is fitted to the Legendre polynomials and shows that the partial waves contributing to the scattering amplitude are S, P, and F. The optical model fit to the data gives a value for the nuclear radius as 0.9 Fermis. (J.F.P.)

37678 REACTIONS $\bar{p}p \rightarrow \bar{\Lambda}\Lambda$ AT 2.5 GeV/c. Badier, J.; Bonnet, A.; Briandet, Ph.; Sadoulet, B. (Ecole Polytechnique, Paris). Phys. Lett., 25B: 152-5(Aug. 7, 1967).

A sample of $\bar{\Lambda}\Lambda$, $\bar{\Lambda}\Sigma^0$, $\bar{\Sigma}^0\Lambda$ was obtained from interactions in hydrogen of antiprotons at 2.434 GeV/c. The total and differential cross sections are given and a comparison with results at other energies is made. The polarizations and spin correlations are evaluated. (auth)

37679 DISCONTINUOUS BEHAVIOUR IN LARGE ANGLE PROTON–PROTON ELASTIC SCATTERING AT HIGH ENERGIES. Allaby, J. V.; Cocconi, G.; Diddens, A. N.; Klovning, A.; Matthiae, G.; Sacharidis, E. J.; Wetherell, A. M. (CERN, Geneva). Phys. Lett., 25B: 156-9(Aug. 7, 1967).

Measurements of elastic proton–proton differential cross sections for angles between 65° and 90° c.m.s. were made at 8, 9, 10, 11, 14, 15 and 21 GeV/c. The shape of the angular distribution is found to change suddenly between 8 and 11 GeV/c. An interpretation of this discontinuous behavior in terms of the reactive effects of baryon–antibaryon pair production is proposed. (auth)

37680 EXPERIMENTAL INVESTIGATIONS OF THE NUCLEON–NUCLEON INTERACTION AT 600 TO 650 MeV. Kazarinov, Yu. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Rev. Mod. Phys., 39: 509-12(July 1967).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

The upper boundary of the unambiguous phase-shift analysis as is known, is at 310 MeV. Above the meson production threshold this unambiguity is absent. In the range from 600–650 MeV where physicists have worked during recent years the scattering amplitude was determined ambiguously and not very reliably. In this connection all the experiments for studying nucleon–nucleon scattering being carried out have two purposes: first, the more accurate determination and improvement of the phase-shift analysis and second, the discrimination of the obtained phase-shift sets for the determination of the most probable set of them. A short survey of some of experiments performed with the above purpose at Dubna in recent years is presented. (auth)

37681 EXPERIMENTAL ASPECTS OF NUCLEON–NUCLEON SCATTERING NEAR 210 MeV: A CRITICAL REVIEW. Thorndike, Edward H. (Univ. of Rochester, N. Y.). Contract AT(30-1)-875. Rev. Mod. Phys., 39: 513-22(July 1967). (UR-875-194).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

Data bearing on the nucleon–nucleon interaction near 210 MeV are reviewed. Proton–proton elastic scattering, neutron–proton elastic scattering (both free and from neutrons bound in deuterium), nucleon–nucleon bremsstrahlung, and tests of invariance principles are discussed. Three-nucleon experiments are mentioned briefly. Some revisions to published N–N scattering data are suggested, and complete tables of data are given. (auth)

37682 A SURVEY OF EXPERIMENTAL RESULTS ON NUCLEON–NUCLEON SCATTERING WORK DONE BY THE ORSAY GROUP. Michalowicz, A. (Institut de Physique Nucleaire, Orsay, France). Rev. Mod. Phys., 39: 523-5(July 1967).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

This report presents experimental results obtained by the Orsay group in France. Firstly, experiments of differential cross section polarization and depolarization in pp scattering at 150 MeV are given. Secondly, polarization and correlation measurements in pp scattering at 600 MeV are given. (auth)

37683 NUCLEON–NUCLEON SCATTERING EXPERIMENTS AT INTERMEDIATE ENERGIES IN BERKELEY. Cheng, David (Univ. of California, Berkeley). Rev. Mod. Phys., 39: 526-30 (July 1967).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

Recent experiments at Berkeley on nucleon–nucleon systems at intermediate energies are discussed. Comparison of experimental results for measurements of parameters using polarized targets agree well with results of experiments not using polarized targets. The advantages and disadvantages of these different methods are discussed briefly. (auth)

37684 POLARIZATION AND C_{NN} MEASUREMENTS BETWEEN 0.5 AND 1.2 GeV. Ducros, Y. (Department de Physique des Particles Elementaires, Saclay, France). Rev. Mod. Phys., 39: 531-3 (July 1967).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

The polarization parameter P was measured at Saclay, at 7 energies, and the C_{NN} parameter at 3 energies. A polarized target and the extracted beam of the synchrotron "Saturne" were used. The beam momentum was known at ±1%. The beam intensity was limited at 10^7 protons in 400 sec. (auth)

37685 SPIN-CORRELATION PARAMETERS IN p–p SCATTERING. Catillon, P. (SPNME, CEN, Saclay, France). Rev. Mod. Phys., 39: 534-5(July 1967).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

Experiments which were done to measure spin-correlation parameters in nucleon–nucleon scattering are summarized, and results compared with phase-shift models. (auth)

37686 MEASUREMENTS OF C_{NN} IN PROTON–PROTON SCATTERING. Beretvas, A. (Univ. of Chicago); Booth, N. E.; Dolnick, C.; Esterling, R. J.; Hill, R. E.; Scheid, J.; Sherden, D.; Yokosawa, A. Rev. Mod. Phys., 39: 536-7(July 1967).

The spin–spin correlation parameter C_{NN} for p–p scattering was measured at 5 energies between 305 and 415 MeV. Measurements were made over the angular range of 50 to 90° in the cm system. A polarized beam, produced by scattering of the internal proton beam of the Chicago cyclotron, and the Argonne polarized proton target were used for the experiment. Results obtained for $C_{NN}(90°)$ are: 0.52 ± 0.08 at 305 MeV, 0.48 ± 0.08 at 330 MeV, 0.50 ± 0.05 at 358 MeV, 0.46 ± 0.06 at 386 MeV, and 0.42 ± 0.04 at 415 MeV. Comparisons with other experimental results and with theoretical and phenomenological models will be made. (auth)

37687 PRESENT AND FUTURE WORK WITH THE HARWELL SYNCHROCYCLOTRON. Whitehead, C. (Atomic Energy Research Establishment, Harwell, Eng.). Rev. Mod. Phys., 39: 538-41(July 1967).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

A brief description of present work at Harwell is given. The final results of the C_{NN} measurements at 73.5, 98, and 142 MeV are given and the status of the precision measurements at 100 MeV is presented. The results of the measurement of the forward cross section for the reaction d(p,n)2p at 95.7 and 143.9 MeV are given and mention is made of recent p, n reaction results. Finally a description is given of the recent 50-MeV p, p differential cross section measurement made at the proton linear accelerator. (auth)

37688 LOW-ENERGY NEUTRON–PROTON POLARIZATION EXPERIMENTS. Simmons, J. E. (Los Alamos Scientific Lab., N. Mex.). Rev. Mod. Phys., 39: 542-5(July 1967).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

The status of N–P scattering and polarization experiments near 25 MeV is reviewed. Recent data on polarization and spin correlation observables are discussed in relation to phase-shift analyses, with some emphasis on the role of the S–D coupling parameter. (auth)

37689 MEASUREMENTS OF THE NEUTRON–PROTON AND NEUTRON–CARBON TOTAL CROSS SECTIONS AT ELECTRON-VOLT ENERGIES. Houk, Theodore L.; Wilson, Richard (Harvard Univ., Cambridge, Mass.). Rev. Mod. Phys., 39: 546-7 (July 1967).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

The neutron–proton total cross section in hydrogen gas and the neutron–carbon total cross section in pyrolytic graphite were measured between 0.3- and 400-eV laboratory energy. After subtracting the capture cross section and molecular binding effects, 20.37 ± 0.02 b was found for the free neutron–proton scattering cross section and 4.7534 ± 0.0045 b for the free neutron–carbon cross section. The effects of these measurements and those of L. Koester on the singlet and triplet n–p scattering lengths and effective ranges are discussed. (auth)

37690 RECENT p–p MEASUREMENTS AT INS, TOKYO, AND p–p PHASE SHIFTS AT 50 MeV: PRELIMINARY RESULTS. Hoshizaki, Norio (Kyoto Univ.). Rev. Mod. Phys., 39: 548-9 (July 1967).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

The p–p differential cross section was remeasured at 52.3 MeV within 1% accuracy by Sanada et al. A phase-shift analysis was made by using these new data and those on C_{nn}, C_{np}, P, D, R, and A. All of these data were normalized at 50.0 MeV. The solution is $^1S_0$ 39.00 ± 0.35, $^1D_2$ 1.97 ± 0.15, $^3P_0$ 12.57 ± 0.52, $^3P_1$ −7.86 ± 0.27, $^3P_2$ 5.98 ± 0.13, ϵ_2 −1.90 ± 0.19, $^3F_2$ 0.43 ± 0.18 (in degrees). The solution shows that the parameters ϵ_2 and $\delta(^3F_2)$ are given essentially by the OPE forces. Other features of the solution are similar to those of the previous one. The values of the $\delta(^1S_0)$ and $\delta(^3P_0)$ of the present solution are larger by about three standard deviations than those given from the Hamada–Johnston potential. (auth)

37691 PHASE-SHIFT ANALYSIS AT HARWELL. Perring, J. K. (Atomic Energy Research Establishment, Harwell, Eng.). Rev. Mod. Phys., 39: 550-5(July 1967).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

Results of recent analyses of proton–proton and neutron–proton data in the 140-MeV region and of proton–proton data at 50 MeV are reported. The existing neutron–proton data in the 25-MeV region are examined and suggestions for experiments are made. It is argued that in fact the available data in this region tell one very little about the interaction. (auth)

37692 OBSERVATION ON EXTREMELY HIGH-ENERGY NUCLEAR EVENTS BY THE EMULSION CHAMBER. Akashi, M. (Hirosaki Univ., Japan); Watanabe, Z.; Nishimura, J.; (and others). Notas Fis., Cent. Brasil. Pesqui. Fis., 12: No. 15, 255-79(1967).

An analysis is presented on the nuclear interactions (incident energy ≥100 TeV) observed by the emulsion chamber exposed at Mt. Chacaltaya and Norikura. Measurements are made on transverse momentum, and energy spectrum of γ-rays (π^0-mesons) and secondary interactions (survival nucleons, charged π-mesons, . . .). The inelasticity of nucleons and mesons and the transverse momentum of a fire ball are derived from the above results. Consistencies are examined among the results of the present work and of others. (auth)

37693 n-p TRIPLE-SCATTERING PARAMETER D_t AT 197 MeV. Spalding, D.; Thomas, A. R.; Thorndike, E. H. (Univ. of Rochester, N. Y.). Phys. Rev., 158: 1338-42(June 25, 1967). (UR-875-185).

The n-p triple-scattering parameter D_t was measured at 197 MeV at three angles. The measurements were made by bombarding a liquid-deuterium target with polarized protons, and spin-analyzing high-energy neutrons recoiling into forward angles. Spin analysis was accomplished by a charge-exchange scattering on CH_2. The measurements are related to the D_t parameter for free n-p scattering through an impulse-approximation calculation which includes the s-wave final-state interaction between the incident proton and the proton in the deuteron. Values obtained for the free np D_t parameter are: +0.095 ± 0.068, −0.014 ± 0.071, and +0.058 ± 0.103 at free n-p center-of-mass scattering angles of 147.4°, 138.6°, and 126.9°, respectively. These values are compared with the phase-shift solutions YLAN of Breit and collaborators, and the energy-independent solution of Arndt and MacGregor. Solutions YLAN 0, 1, 2, 2M, 3, and the Arndt-MacGregor solution do not agree with the data. Solutions YLAN 3M and 4M fit the data quite well. (auth)

37694 EXPERIMENTAL TEST OF BARYON CONSERVATION. Gurr, H. S. (Case Inst. of Tech., Cleveland); Kropp, W. R.; Reines, F.; Meyer, B. Phys. Rev., 158: 1321-30(June 25, 1967).

A 162-m^2 sr scintillation detector located 3200 m underground was used to look for high-energy fragments from baryon-nonconserving nucleon decay. A new lower limit on the half-life of the nucleon from 2×10^{28} to 8×10^{29} years, depending on the assumed decay mode, is established. (auth)

37695 KAONIC ANNIHILATIONS OF ANTIPROTONS IN HYDROGEN AT 7 GeV/c. Yeh, N. (Yale Univ., New Haven); Chien, C. Y.; Lach, J.; Sandweiss, J.; Taft, H. D.; Oren, Y.; Webster, M. S. Phys. Rev., 158: 1275-81(June 25, 1967). (BNL-11166).

Results are reported from an analysis of 80,000 pictures of 6.935-BeV/c antiprotons in hydrogen leading to final states of the form $K_1^0 + K_1^0 + m\pi$, m = 0,1,2 . . . . Assuming equal probability for the various $K\bar{K}$ charged states, the cross section for the reaction $\bar{p} + p \rightarrow K + \bar{K} + m\pi$ was found to be 2.5 ± 0.5 mb. A compilation of annihilation cross sections indicates that the kaonic-annihilation final states constitute approximately 10% of all annihilations from ~1.6–7 BeV/c. The production of K*(1400) was observed, although the formation of other resonances such as K* (890), ω, and ρ is less copious at 7 BeV/c than at 3.7 BeV/c. A $K_1^0K_1^0$ enhancement near threshold is observed similar to that observed at lower-energy annihilation reactions. (auth)

37696 FURTHER STUDY OF THE E-MESON IN ANTIPROTON–PROTON ANNIHILATIONS AT REST. Baillon, P. (CERN, Geneva); Edwards, D.; Marechal, B.; (and others). Nuovo Cim. (10), 50A: 393-421(Aug. 1, 1967).

In the study of the annihilation $\bar{p}p \rightarrow K\bar{K}\pi\pi\pi$ at rest, an important enhancement in the $(K\bar{K}\pi)$ neutral system was observed. It is shown that this enhancement is the manifestation of a resonance, which is called the E^0 meson, with quantum numbers M = (1425 ± 7) MeV, Γ = (80 ± 10) MeV, $I^GJ^P = 0^+0^-$ and branching ratio $E \rightarrow K^*\bar{K}(\bar{K}^*K)/E \rightarrow (K\bar{K})\pi = 1$. (auth)

Strong (Meson-Induced)

Refer also to abstract 37657.

37697 (BNL-11598) ABSORPTION CROSS SECTIONS FOR HIGH ENERGY PROTONS, ANTIPROTONS AND π AND K MESONS ON NUCLEI. Galbraith, W.; Jenkins, E. W.; Kycia, T. F.; Leontic, B. A.; Phillips, R. H.; Read, A. L. (Brookhaven National Lab., Upton, N. Y.); Rubinstein, R. (Cornell Univ., Ithaca, N. Y. Lab. of Nuclear Studies). [1966]. 9p. Dep. CFSTI.

Absorption cross sections for $\pi^{\pm}$, $K^{\pm}$, and $p^{\pm}$ were measured on carbon, aluminum, copper, tin, and lead, at incident momenta of 10.8 and 18.0 GeV/c. The results for each particle and momentum can be fitted by the expression $\sigma_{absorption} = \pi(r_0 A^{1/3})^2$; comparisons between the data and an approximation to the more exact transparency calculations also show good agreement. (auth)

37698 (COO-1195-87) PART ONE. THE REACTION $K^- d \rightarrow \bar{K}^0 nn$, FROM THRESHOLD TO 300 MeV/c. PART TWO. $K^+ p$ ELASTIC SCATTERING: 80 TO 280 MeV/c. Lansford, Robert Maurice (Illinois Univ., Urbana. Dept. of Physics). 1967. Contract AT(11-1)-1195. 97p. Dep. CFSTI.

Thesis.

The cross section for the interaction $K^- + d \rightarrow \bar{K}^0 + n + n$ was measured for the laboratory momentum interval from threshold (96.7) to 300 MeV/c. The cross section is found to rise quickly above threshold to around 6 mb at 150 MeV/c, then decrease slowly from 150 to 300 MeV/c. This cross section is consistent with even parity and agrees reasonably well with recent three-body calculations. Angular distributions were presented which indicate that low partial waves are taking part. An experiment was also performed using the hydrogen bubble chamber to measure the low-energy $K^+ + p$ elastic scattering cross section. The differential cross section is found to be flat and to vary little with increasing momentum. (J.F.P.)

37699 (COO-1428-29) HIGH ENERGY PARTICLE PHYSICS. Annual Progress Report, June 1, 1966–May 31, 1967. Tautfest, G. W. (Purdue Univ., Lafayette, Ind. Dept. of Physics). July 12, 1967. Contract AT(11-1)-1428. 19p. Dep. CFSTI.

Various meson–nucleon and meson–deuteron interactions at high energies are described. Also various computer programs used in the data analysis are briefly mentioned. (J.F.P.)

37700 (INR-793/VI/PH) THE LOWER LIMIT OF TRANSVERSE MOMENTUM AND FOUR-MOMENTUM TRANSFER OF RECOIL PROTONS IN HIGH-ENERGY INTERACTIONS OF SECONDARY PARTICLES COMING FROM COSMIC RAY JETS. Babecki, Jan (Institute of Nuclear Research, Warsaw (Poland)). 1967. 13p. Dep.

The determination of the transverse momenta and four-momenta of recoil protons in the interactions of high-energy secondary cosmic ray particles, a large fraction of which corresponds to π-nucleon interactions, as well as a comparison of results with those obtained previously for nucleon-nucleon collisions was made. The method applied was based on the calculation of transverse momenta and four-momenta for all jet tracks assuming that a given track belongs to recoil proton and on further selection of the smallest possible value of $p_\perp$ and δ_2. For secondary jets, as previously for primary ones, distributions of the smallest possible $p_\perp$-values of recoil protons were obtained, average $p_\perp$-values being considerably larger than those of pions. Accordingly the obtained values of four-momentum of recoil protons are also large, of the order of several GeV/c. (auth)

37701 N* PRODUCTION IN π^+-p AND p–p INTERACTIONS. Foley, K. J.; Jones, R. S.; Lindenbaum, S. J.; Love, W. A.; Ozaki, S.; Platner, E. D.; Quarles, C. A.; Willen, E. H. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 19: 397-9(Aug. 14, 1967).

The production of a peak corresponding to a recoiling baryon of mass 1.4 MeV and the 1.24-, 1.52-, and 1.69-BeV isobars was observed in the π^+-p as well as p–p interactions in the range of four-momentum transfer $0.01 < |t| < 0.2$ $(BeV/c)^2$ at incident lab momenta from 10 to 26 BeV/c. It was observed that the momentum spectra at a given t appear to have about the same shape for all three channels (π^+-p and p–p) relatively independent of incident energy, and the ratio of cross sections for isobar production by incident pions compared with that for incident protons is essentially the same as the ratio of the elastic cross sections. (L.B.S.)

37702 BACKWARD PEAKS IN ELASTIC PION–PROTON SCATTERING FROM 6 TO 17 GeV/c. Ashmore, A. (Brookhaven National Lab., Upton, N. Y.); Damerell, C. J. S.; Frisken, W. R.; Rubinstein, R.; Orear, J.; Owen, D. P.; Peterson, F. C.; Read, A. L.; Ryan, D. G.; White, D. H. Phys. Rev. Lett., 19: 460-3(Aug. 21, 1967).

The energy dependence, charge dependence, and angular distributions of pion-proton elastic scattering near 180° were measured at beam momenta from 5.9 to 17.1 GeV/c. The 180° cross sections decrease with energy as $P_{lab}^{-1.1}$ for π^--p and $P_{lab}^{-1.4}$ for π^+-p. At all energies the π^+-p backward peak is quite sharp and has a width about ½ that of the forward diffraction peak. The π^--p backward peaks are about twice as wide as the forward diffraction peak and appear to go through a maximum before reaching 180°. (auth)

37703 SPIN AND PARITY OF THE $N_\alpha^*(2420)$. Bellamy, E. H. (Westfield Coll., London); Buckley, T. F.; Dobinson, R. W.; (and others). Phys. Rev. Lett., 19: 476-8(Aug. 21, 1967).

The preliminary results of an elastic scattering experiment of positive mesons (π) on protons were obtained. The differential cross sections were measured at ten incident meson (π) momenta between 1.72 and 2.8 GeV/c and a qualitative analysis is presented which suggests that the enhancement seen in the $\pi^+ + p$ total cross section at a cms energy of 2420 MeV may be explained by an $11/2^+$ resonance. (J.F.P.)

37704 MESON AND ISOBAR RESONANCE PRODUCTION IN π^-p INTERACTIONS AT 3.63 GeV/c. Lee, Y. Y.; Moebs, W. D. C.; Roe, B. P.; Sinclair, D.; Vander Velde, J. C. (Univ. of Michigan, Ann Arbor). Phys. Rev., 159: 1156-68(July 25, 1967).

π^-p interactions at 3.63 BeV/c were studied using the BNL 20-in. hydrogen bubble chamber. 1054, 1693, 805, 1025, and 489 events of the reaction types (1) $\pi^- + p \rightarrow \pi^- + \pi^0 + p$, (2) $\pi^- + p \rightarrow \pi^- + \pi^+ + n$, (3) $\pi^- + p \rightarrow \pi^- + \pi^- + \pi^+ + p$, (4) $\pi^- + p \rightarrow \pi^- + \pi^- + \pi^+ + p + \pi^0$, and (5) $\pi^- + p \rightarrow \pi^- + \pi^- + \pi^+ + \pi^+ + n$, respectively, were identified. The ρ meson is produced abundantly in reactions (1) and (2), and an analysis of the decay angular distributions of the events in these peaks leads one to believe that they are produced via pion-pion scattering in states of angular-momentum zero and one. A detailed analysis of the energy and momentum-transfer dependence of the phase shifts necessary to describe such scattering is made. Using the Chew-Low method, the results were extrapolated into the non-physical region of momentum transfer, and are found to agree quite well quantitatively with predicted values. Reaction (3) is found to be dominated by ρ^0 and $N^*(1238)$ production. ρ^- and ω^0 production are the dominant features of reaction (4). Both of these mesons seem to be produced along with nucleon isobars. The ρ^- channel furnishes examples of these isobars decaying into a pion and into the 1238-MeV N*, which in turn breaks up into a π^+ and a p. A peak is also found in the $(\pi^-\omega^0)$ mass spectrum at 1250 MeV. Cross sections for the reactions and the various resonance channels are also presented. (auth)

37705 ELASTIC DIFFERENTIAL CROSS SECTIONS FOR $\pi^{\pm}$ + p SCATTERING FROM 2.3 TO 6.0 GeV/c. Coffin, C. T.; Dikmen, N.; Ettlinger, L.; Meyer, D.; Saulys, A.; Terwilliger, K.; Williams, D. (Univ. of Michigan, Ann Arbor). Phys. Rev., 159: 1169-75(July 25, 1967). (COO-1112-105).

Elastic differential cross sections were measured at 6 energies between 2.3 and 6 BeV/c for $\pi^+ + p$ and $\pi^- + p$. The behavior of the secondary peak as a function of energy and charge is shown. Evidence for considerable resonance structure is seen in the angular distributions. (auth)

37706 PHOTOPRODUCTION OF π^0 FROM HYDROGEN NEAR THE SECOND AND THIRD PION-NUCLEON RESONANCES. Ward, C.; Kenton, B.; York, C. (Univ. of California, Los Angeles). Phys. Rev., 159: 1176-86(July 25, 1967).

Measurements of the differential cross section for the process $\gamma + p \rightarrow \pi^0 + p$ were made at eight pion center-of-mass angles in the range 51 to 135° and for incident photon energies from approximately 600 to 1200 MeV. The bremsstrahlung photon beam used was obtained from the California Institute of Technology electron synchrotron. Both the recoil proton and one γ ray from the decay of the π^0 were detected. The incident photon energy was determined by measuring the laboratory angle and time of flight of the recoil proton. The angular distributions obtained indicate that the third pion-nucleon resonance is predominantly a $D(5/2)$ resonance excited by a magnetic quadrupole transition. It can also be concluded that any contribution to the π^0 photoproduction cross section from a virtual vector-meson exchange process is probably negligible in the region of the second and third pion-nucleon resonances. (auth)

37707 NEUTRAL DECAY OF THE ω MESON. Feldman, M.; Frati, W.; Gleeson, R.; Halpern, J.; Nussbaum, M.; Richert, S. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 159: 1219-21 (July 25, 1967).

The reaction $\pi^- + p \rightarrow \omega + n$ at 1.2 BeV/c was detected by counter techniques. Recoil neutrons were detected in a scintillation counter array at $\theta_n = 20 \pm 2°$, and their velocity determined by a time-of-flight measurement. Measurement of the neutron direction and velocity determined the ω mass with resolution ± 15 MeV, and enabled separation of ω production from background. Scintillation counters surrounding the hydrogen target distinguished charged from neutral ω decays, yielding a branching ratio: $\Gamma_{neutral}/\Gamma_{charged} = 0.124 \pm 0.021$. Neutral ω decays were directly observed by conversion of the resulting γ rays in a lead-plate spark-chamber array. Events with three observed γ's were fitted to the decay $\omega \rightarrow \pi^0 + \gamma \rightarrow 3\gamma$ (a two-constraint fit). Twenty-six fits with $\chi^2 < 5$ were found, of which five are estimated to be background. If $\omega \rightarrow \pi^0 + \gamma$ is the only neutral mode, then we expect 29 observed $\pi^0\gamma$ decays, as calculated from the recoil-neutron measurements and spark-chamber

efficiency. Thus our data give clear evidence that the mode $\omega \rightarrow \pi^0 + \gamma$ represents a substantial fraction (consistent with 100%) of the ω neutral decays. (auth)

37708 HIGH-PRECISION $\pi^{\pm}$-p TOTAL CROSS SECTIONS FROM 8 TO 29 BeV/c. Foley, K. J.; Jones, R. S.; Lindenbaum, S. J.; Love, W. A.; Ozaki, S.; Platner, E. D.; Quarles, C. A.; Willen, E. H. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett. 19: 330-2(Aug. 7, 1967).

The total cross section from 8 to 29 GeV/c for π^- + p and from 8 to 22 GeV/c for π^+ + p was measured using a counter–hodoscope system to obtain an absolute accuracy of 0.3%. The improved accuracy was necessary for investigation of asymptotic behavior and to reduce systematic uncertainty in a recent test of the validity of the forward dispersion relations. The total cross section vs laboratory momentum is given. (J.F.P.)

37709 PRODUCTION OF THE NEUTRAL A_2 MESON IN THE REACTION $\pi^+ + p \rightarrow N^{*++} + \pi^+ + \pi^- + \pi^0$. Baltay, C. (Columbia Univ., New York. Brookhaven National Lab., Upton, N. Y.); Kirsch, L.; Kung, H. H.; Yeh, N.; Rabin, M. Phys. Lett., 25B: 160-3 (Aug. 7, 1967).

The neutral component of the A_2 meson was observed in the reaction $\pi^+ + p \rightarrow N^{*++}(1238) + \pi^+ + \pi^- + \pi^0$ at 8.5 GeV/c. The mass and width of the A_2 as seen in this experiment are M = 1285 ± 20 MeV and Γ = 100 ± 25 MeV, and the isotopic spin, G parity, spin and parity are consistent with the values reported for the charged A_2 mesons. Isotopic spin 2 can be conclusively ruled out. (auth)

37710 TWO-PRONG + K_1^0 EVENTS IN K⁻d INTERACTIONS AT 2.24 GeV/c. Galloway, K. F.; DeRemer, R. J.; Alyea, E. D. Jr., Crittenden, R. R.; Martin, H. J. Jr.; Scandrett, J. H. (Indiana Univ., Bloomington). Phys. Rev., 158: 1359-64(June 25, 1967).

A total of 702 events with two charged particles and a K_1^0 meson in the final state were measured. Three hundred and eighty-five of these events represented the $K^-d \rightarrow \overline{K}^0\pi^-pn$ reaction and they were divided, using the spectator model, into 247 $K^-p \rightarrow \overline{K}^0p\pi^-$ events and 138 $K^-n \rightarrow \overline{K}^0\pi^-n$ events. Both reactions show resonance production. The $K^-p \rightarrow \overline{K}^0\pi^-p$ reaction has (56 ± 5)% $K^{*-}p$ final state; the $K^-n \rightarrow \overline{K}^0\pi^-n$ reaction has equal N^{*-} and K^{*-} production, (26 ± 8)% $K^{*-}n$ in the final state and (25 ± 8)% $\overline{K}^0N^{*-}$. Angular distributions and information on other final states are also given. (auth)

37711 CHARGED DOUBLE PION PRODUCTION IN π^+p SCATTERING AT 910 MeV/c. Broderick, J. L. (St. Louis Univ.); Tilger, C. A.; Delaney, R. M.; Poirier, C. P. Phys. Rev., 158: 1331-4(June 25, 1967).

The final state $p\pi^+\pi^+\pi^-$ produced in π^+p scattering at 910 MeV/c was studied. A total of 82 events were identified as belonging to that final state yielding a cross section of 0.43 ± 0.06 mb. The data indicate that this final state contains the N*(1238). The $\pi^+\pi^+$ and π^-p mass spectra are consistent with Lorentz-invariant phase space, but the $\pi^+\pi^-$ mass spectrum shows an enhancement at a mass of 400 MeV. The data are compared with the predictions of a simple isobar model. (auth)

37712 REACTION $K^+p \rightarrow K^+p\pi^+\pi^-$ AT 2.26 GeV/c. Bomse, Frederick; Borenstein, Samuel; Cole, James; (and others) (Johns Hopkins Univ., Baltimore). Phys. Rev., 158: 1281-97(June 25, 1967).

The reaction $K^+p \rightarrow K^+p\pi^+\pi^-$ at 2.26 BeV/c is investigated. It is found to be dominated by the simultaneous production of the K* (895 MeV) and N* (1238 MeV) resonances. The production and decay angular distributions of these resonances in the double-resonance channel are analyzed and the results compared with the predictions of a single-particle-exchange model. These distributions are consistent with the assumption that the primary production mechanism responsible for the reaction $K^+p \rightarrow K^{*0}N^{*++} \rightarrow K^+\pi^-\pi^+p$ at 2.26 BeV/c is the exchange of a single π meson. A search is conducted in this channel for other possible resonant states. A Monte Carlo analysis is utilized for this purpose. The data are not found to be consistent with the production of any other resonances except the aforementioned K* (895 MeV) and N* (1238 MeV). (auth)

37713 REACTION $K^+p \rightarrow K^0\pi^+p$ AT 2.26 GeV/c. Bomse, Frederick; Borenstein, Samuel; Cole, James; (and others) (Johns Hopkins Univ., Baltimore). Phys. Rev., 158: 1298-1309(June 25, 1967).

The properties of the K* (895 MeV) and N* (1238 MeV) resonances produced in the reaction $K^+p \rightarrow K^0\pi^+p$ at 2.26 BeV/c are studied. The production of one or the other of these resonances is found to occur in this channel 80% of the time. The decay correlations of the K* and N* indicate that the dominant mechanism involved in their production may be single-vector-meson exchange. In particular, the decay angular distributions of the N* are in good agreement with the predictions of the Stodolsky-Sakurai model. The experimental differential cross sections for production of each of these resonances are also compared with theoretical predictions based on a single-meson-exchange model which includes the effects of absorption due to competing channels. The agreement of the data with the theory is found to be only moderate here. (auth)

37714 INELASTIC K^+-PROTON INTERACTIONS AT 2.65 GeV/c. Newman, R. (Univ. of California, Berkeley); Chinowsky, W.; Schultz, J.; Johnson, W. B.; Larsen, R. R. Phys. Rev., 158: 1310-20(June 25, 1967).

Pion production by 2.65-BeV/c K^+ mesons interacting in the BNL 20-in. hydrogen bubble chamber has been investigated. It is found that these inelastic events are dominated by K* (891) and N* (1236) production. Based on 537 three- and four-body events, the cross sections for production of $K^0p\pi^+$ and $K^+p\pi^+\pi^-$ are 2.7 ± 0.3 and 2.5 ± 0.2 mb, respectively. The three-body final states contain 56% K*p and 32% N^*K^0, while the four-body states contain 9% $K^*p\pi^+$, 19% $N^*K\pi^-$, and 53% K^*N^*. Resonance production is compared with predictions of several versions of the one-meson-exchange model. Although agreement with the data is not exact, the models tend to reproduce a number of qualitative features of the experimental results. (auth)

37715 MEASUREMENTS OF DIFFERENTIAL CROSS SECTIONS FOR $\pi^{\pm}$ + p AT 410 AND 490 MeV IN THE FORWARD DIRECTION. Banner, M. (CEN, Saclay, France); Detoeuf, J. F.; Fayoux, M. L.; Hamel, J. L.; Movchet, J.; van Rossum, L.; Cheze, J.; Teiger, J.; Zsembery, J. Nuovo Cim. (10), 50A: 431-48 (Aug. 1, 1967). (In French).

Measurements of $\pi^{\pm}p$ elastic differential cross sections were performed in the forward direction, using a missing-mass spark chamber spectrometer. The films were scanned by an automatic apparatus. A phase-shift analysis of the experimental data was done, leading to three solutions. Various experiments are proposed in order to resolve the ambiguities. (auth)

37716 A STUDY OF RESONANCE PRODUCTION IN 7 GeV/c π^+p INTERACTIONS. Slattery, P. (Yale Univ., New Haven); Kraybill, H.; Forman, B.; Ferbel, T. Nuovo Cim. (10), 50A: 377-92(Aug. 1, 1967).

A preliminary investigation of resonance production in 7 GeV/c π^+p interactions indicates that the production rates and characteristics of the A_1, the A_2, and the B mesons are similar to those observed at lower energies. The cross-section for the channel N* (1238) + A_2 is comparable in size to that for $p + A_2^+$ (~200 μb). Small A_1 and B enhancements are evident in the data. A model which considers the peripheral nature of the pion–nucleon interaction is found to be only partially successful in accounting for the A_1 and the B on the basis of their being kinematic reflections. (auth)

37717 EVIDENCE FOR A $\Sigma^-\eta$ ENHANCEMENT NEAR THRESHOLD. Cline, D.; Olsson, M. G. (Univ. of Wisconsin, Madison). Phys. Lett., 25B: 41-4(July 24, 1967).

Evidence from a deuterium bubble chamber experiment is presented for a large cross section for the process $K^-n \rightarrow \Sigma^-\eta$ in the center of mass energy region of 1746 to 1900 MeV. Using the Fermi momentum of the neutron in D_2 the cross section is shown to fall with increasing center of mass energy. The threshold enhancement appears to be similar to that observed in the $K^-p \rightarrow \Lambda\eta$ and $\pi^-p \rightarrow n\eta$ systems. (auth)

37718 EVIDENCE FOR A TWO-PEAK STRUCTURE IN THE A_2 MESON. Chikovani, G. (Inst. of Physics, Tbilisi, USSR); Focacci, M. N.; Kienzle, W.; (and others). Phys. Lett., 25B: 44-7(July 24, 1967).

The missing-mass spectrum of the A_2 meson [M = 1297 ± 16 MeV, Γ = 95 ± 15 MeV] obtained in the reaction $\pi^-p \rightarrow pX^-$ in three independent runs at 6 and 7 GeV/c shows a narrow dip of 6 standard deviations in the centre of the A_2 peak at 1297 MeV, thus suggesting a two-peak structure. (auth)

37719 QUANTUM NUMBER ASSIGNMENT FOR THE A_2^0 MESON. Bartsch, J. (Technische Hochschule, Aachen); Deutschmann, M.; Kraus, G.; (and others). Phys. Lett., 25B: 48-52 (July 24, 1967).

An enhancement is observed at 1310 MeV in the neutral 3 pion system in the reaction $\pi^+p \rightarrow N^{*++}\pi^+\pi^-\pi^0$. Evidence is presented for the assignment of spin-parity $J^P = 2^+$ and isospin = 1 for this resonance. (auth)

37720 A_2^0 PRODUCTION IN π^+d INTERACTION. Armenise, N. (Univ., Bari, Italy. Istituto Nazionale Fisica Nucleare, Bari, Italy); Ghidini, B.; Picciarelli, V.; (and others). Phys. Lett., 25B: 53-6(July 24, 1967).

In ($\pi^+\pi^-\pi^0$) invariant mass from the reaction $\pi^+ d \to p_s p\pi^+\pi^-\pi^0$ at 5.1 GeV/c in the 81 cm Saclay deuterium bubble chamber exposed at CERN PS, a peak was observed at 1.32 ± 0.01 GeV with Γ = 0.12 ± 0.02 GeV. This peak has a $\rho\pi$ structure and corresponds to a T = 1, $J^P = 2^+$ resonant state. (auth)

Particle Interactions and Properties (Theoretical)

General

37721 (NP-16895) LOESUNG DER BETHE-SALPETER-GLEICHUNG MIT HILFE DER RIEMANNSCHEN METHODE. (Solution of the Bethe-Salpeter Equation With the Help of the Riemann Method). Honerkamp, Josef (Hamburg Univ. (West Germany). II. Institut fuer Theoretische Physik (II)). [1966]. 56p. (In German). Dep.

The Bethe-Salpeter equation (BSG) describing the interaction of two scalar particles via the exchange of a third scalar particle with mass $\mu \neq 0$ is, in configuration space, a hyperbolic partial differential equation of fourth order which will be studied with the help of the Riemann method. This method yields two Volterra integral equations analogous to the one occurring in Jost and Newton's treatment of the Schrödinger equation, and these can be solved by iteration in the same manner. The solutions are special solutions of the BSG corresponding to the special solution, $\varphi(k,\tau)$, of the Schrödinger equation, and the solution of the BSG with causal boundary conditions is then a superposition of these special solutions. The Riemann function is calculated from the causal Green's function, which can be split up into a retarded Green's function and two residual terms. The retarded Green's function is closely related to the Riemann function, while the residual terms give information about the coefficients of the expansion in terms of the special solutions. For these coefficients one gets a system of two integral equations in one variable, whose Fredholm determinant is the generalization of the nonrelativistic Jost function. (auth)

37722 THEOREM ON C-NUMBER SCHWINGER TERM. Lu, Eugene Y. C. (Cambridge Univ., Eng.). Phys. Rev., 159: 1427-8(July 25, 1967).

A generalized version of Weinberg's theorem on c-number Schwinger terms is proved. If the vector and axial-vector currents obey the usual commutation relations with only c-number Schwinger terms, then the c-number Schwinger terms in the vector current commutator and the axial-vector current commutator are equal. The numerical predictions of the theorem on 1^+ and 1^- meson spectra are unaffected. (auth)

37723 UPPER BOUND ON POSSIBLE MASS SPECTRA FROM SINGLE-PARTICLE SATURATION OF CURRENT ALGEBRA SUM RULES. Grodsky, I. T.; Martinis, M.; Swiecki, M. (International Atomic Energy Agency, Trieste, Italy). Phys. Rev. Lett., 19: 332-5(Aug. 7, 1967). (IC-67/35).

It is demonstrated that the saturation of current-algebra sum rules by single-particle intermediate states implies a strong limitation on the mass spectrum: m(j) cannot grow asymptotically faster than j, the spin of the particle. In order to avoid as much complication as possible due to external spin, a sum rule obtained by sandwiching the commutator of a vector and scalar density between spinless single-particle states is treated. (J.F.P.)

37724 ELEMENTARY AND COMPOSITE PARTICLES IN THE V−θ SECTOR OF THE LEE MODEL. Choudhury, S. Rai (Princeton Univ., N. J.); Srivastava, P. K. Nucl. Phys., B2: 441-8(1967).

The V−θ sector of the Lee model is examined with a view of understanding composite particles as elementary particles with vanishing renormalization constant, in the presence of inelasticity. It is shown that a composite bound state in the V−θ sector is equivalent to an elementary one in a second field theory, with the wave function renormalization constant of the elementary particle tending to zero. However unlike the case where the scattering is purely elastic, there does not seem to be any simple and useful relation between the phase of the elastic scattering amplitude at infinite energies and the compositeness of the bound states in the V−θ channel. The meaning of a vanishing vertex renormalization constant is also studied in the second field theory and it is shown that the simultaneous vanishing of both the vertex and wave function renormalization constant constitute the field theoretic definition of bootstrap. (auth)

37725 STATIONARY-PHASE APPROXIMATION OF FEYNMAN PATH INTEGRALS. II. Lam, C. S. (McGill Univ., Montreal). Nuovo Cim. (10), 50A: 504-10(Aug. 1, 1967).

It was shown previously that the matrix element $\langle x_2 t_2/x_1 t_1\rangle$ for a harmonic oscillator perturbed by an anharmonic potential $\lambda(m\omega^2/4l^2)x^4$, or the matrix element $\langle\varphi_2 t_2/\varphi_1 t_1\rangle$ for a neutral scalar field with self-interaction $\lambda\varphi^4$, is not given by the usual perturbation expansion even in the limit $0 < \lambda \ll 1$. In addition to the usual perturbation series, there were extra series with an essential singularity at λ = 0 of the form exp [i/λ]. It is shown that these extra series are absent in the matrix element $\langle\psi_0 t_2/\psi_0 t_1\rangle$, where ψ_0 is the ground state of the unperturbed system. As a result, the ordinary perturbation series alone is a valid asymptotic expansion of the matrix element. The essential physical reason behind this difference for these two matrix elements is discussed for both signs of λ. (auth)

37726 LORENTZ-INVARIANT LOCALIZATION FOR ELEMENTARY SYSTEMS. Gallardo, Juan C.; Kalnay, Andres J.; Risemberg, Salomon H. (Univ., Cordoba, Argentina). Phys. Rev., 158: 1484-90(June 25, 1967).

Philips has axiomatically defined sets of localized states which are Lorentz-invariant (while Newton−Wigner sets of localized states are not) and has divided these sets into three classes. Philips's conjecture concerning spin-zero localized states, namely, that the postulates define the sets of localized states in a unique way, is proved to be incorrect by finding a class-III set that satisfies Philips's postulates. Philips's work is discussed and his calculations (spin-zero case) are repeated without using some (explicit and implicit) unnecessary hypotheses. These calculations are also extended to the spin-½ case, for which it is proved that there are only class-III sets of localized states. The results are discussed. Incidentally, an explicit form of the effects induced by a Lorentz transformation on representation space is found for both the spin-zero and spin-½ cases. (auth)

37727 SOURCES AND ELECTRODYNAMICS. Schwinger, Julian (Harvard Univ., Cambridge, Mass.). Phys. Rev., 158: 1391-1407(June 25, 1967).

A new kind of particle theory is being explored, one that is intermediate in concept between the extremes of S matrix and field theory. It employs the methods of neither approach. There are no operators, and there is no appeal to analyticity in momentum space. It is a phenomenological theory, and cognizant that measurements are operations in space and time. Particles are defined realistically by reference to their creation or annihilation in suitable collisions. The source is introduced as an abstraction of the role played by all the other particles involved in such acts. Through the use of sources the production and detection of particles, as well as their interaction, are incorporated into the theoretical description. There is a creative principle that replaces the devices of other formulations. It is an insistence upon the generality of the space-time description of the coupling among other sources that is inferred from a specific spatio-temporal arrangement, in which various particles propagate between sources. Standard quantum-mechanical and relativistic requirements, imposed on the source description of noninteracting particles, imply the existence of the two statistics and the connection with spin. In this situation sources are only required to emit and absorb the mass of the corresponding particle. Particle dynamics is introduced by an extension of the source concept. It is considered meaningful for a source to emit several particles with the same total quantum numbers as a single particle, if sufficient mass is available. This is most familiar as the photon radiation that accompanies the emission of charged particles. The new types of sources introduced in this way imply new couplings among sources, which supply still further varieties of sources. This proliferation of interactions spans the full dynamical content of the initial primitive interaction. The ambition of the phenomenological source theory is to represent all dynamical aspects of particles, within a certain context, by a suitable primitive interaction. This paper is devoted to the reconstruction of electrodynamics. (auth)

37728 KINEMATIC PARAMETER FOR ESTIMATING THE PRIMARY ENERGY AND FOR STUDYING NUCLEAR INTERACTIONS FROM 17 TO ~10^3 GeV. Kim, C. O. (Louisiana State Univ., Baton Rouge). Phys. Rev., 158: 1261-74(June 25, 1967).

The kinematic parameter $\eta = \text{arctanh}(\beta\cos\theta)$ for a secondary of a jet transforms from the laboratory system (LS) to η^* in a frame of reference moving with a velocity β_c with respect to the LS in the direction of the incident primary, according to the relation $\eta = \eta^* + \text{arctanh}\,\beta_c$. Then the velocity β_S of a "symmetric system," of a group of produced secondaries for which the mean value of η statistically vanishes, is obtained from the formula $\text{arctanh}\,\beta_S = \langle\eta\rangle$, which usually reduces to $\ln\gamma_S = -\langle\ln\tan\theta\rangle - \langle\ln[(1+x^2)^{1/2}x^{-1}]\rangle$, where $x = p_z/m$. For the usual situation where only the emission angles of a subset of charged secondaries of a jet is known, a parameter $\eta(\theta) \simeq 0.46 - \ln\tan\theta$, which depends only on θ but which is consistent with the definition of η, is introduced, and the rather well-known distribution of the transverse momentum of pion secondaries is used in place of knowledge of

values of β to calculate results based on the use of η. The $E(\theta)$ method, in which one substitutes $\langle\eta(\theta)\rangle$ for $\langle\eta\rangle$ to find the velocity of the symmetric system, β_S, is an improvement over the spectrum-independent formula by Castagnoli et al., $\ln\gamma_{CM} = -\langle\ln\tan\theta\rangle$, for estimating the primary energies of jets. This is shown with accelerator-produced jets with energies ranging from 17 to 30.9 GeV and cosmic-ray jets with energies around 10^3 GeV. Also studied are the magnitude of the statistical error in using the $E(\theta)$ method and various aspects of the problem of multiple production of particles which were determined by examining the $\eta(\theta)$ distributions of jets and their dependence on the primary energy. (auth)

37729 A GENERALIZED DALITZ PLOT FOR FOUR-PARTICLE FINAL STATES. Chodrow, D. (Harvard Univ., Cambridge, Mass.). Nuovo Cim. (10), 50A: 674-7(Aug. 1, 1967).

A method for constructing a generalized Dalitz plot for four-particle final states is presented. It is found that the density of events can be plotted, and resonances may be directly read off the plot. The four-body phase-space integral is more complicated than that for three-body phase space, thus the four-body phase-space integral is usually evaluated numerically. (J.F.P.)

37730 SIMILARITY BETWEEN THE MEDIUM-STRONG SYMMETRY-BREAKING AND NONLEPTONIC WEAK INTERACTIONS. Nakagawa, M.; Trofimenkoff, N. N. (Australian National Univ., Canberra). Nuovo Cim. (10), 50A: 657-60(Aug. 1, 1967).

Since the proposal of the Okubo mass formula, it was realized that the mass splitting in a supermultiplet of hadrons is caused by a perturbation that transforms dominantly like a member of an SU(3) octet. Also the S-wave amplitudes of nonleptonic hyperon decay can be explained by the current algebra PCAC technique if octet dominance is assumed for the weak interaction. A similarity between the octet dominance in these two interactions is discussed. (J.F.P.)

37731 SCHWINGER TERMS IN PERTURBATION THEORY. Hamprecht, B. (Univ., Turin). Nuovo Cim. (10), 50A: 449-57 (Aug. 1, 1967).

Schwinger terms in current commutators are determined in a quark model, using perturbation theory. It is found that the equal-time commutator of two time components of vector currents contains no Schwinger terms, whereas the commutator of a time and a space component of vector currents contains a Schwinger term proportional to the derivative of a δ-function. The commutators of time components of axial and vector currents are also free from Schwinger terms, so that the local $SU_3 \times SU_3$ algebra recently proposed by Gell-Mann is unaffected. (auth)

37732 GRAVITATIONAL SCATTERING OF LIGHT BY LIGHT. Barker, Bruce M. (Univ. of Windsor, Ont.); Bhatia, Manjit S.; Gupta, Suraj N. Phys. Rev., 158: 1498-9(June 25, 1967).

The photon–photon interaction through the creation and annihilation of a virtual graviton is investigated in the center-of-mass system, and is found to have eight times the Newtonian value plus a polarization-dependent repulsive contact interaction. The gravitational scattering cross sections for various states of photon polarizations are obtained. (auth)

37733 COMPOSITENESS CRITERION FOR THE TARGET PARTICLES. Matsumoto, Yasuo (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 37: 1034-6(May 1967).

The compositeness of target particles in two particle scattering processes is developed by showing that, for a target particle to become a dynamical bound state, the wave-function renormalization constant of the particle must vanish. This holds for all target particles in the charged scalar static model with the two-meson approximation except for a certain class of nonlocal interactions. (L.B.S.)

37734 INTERNATIONAL CONFERENCE ON THE NUCLEON-NUCLEON INTERACTION, HELD AT UNIVERSITY OF FLORIDA, GAINESVILLE, MARCH 23-25, 1967. Green, A. E. S.; MacGregor, M. H.; Wilson, R. (eds.). Rev. Mod. Phys., 39: 495-717 (July 1967). (CONF-670302).

The conference includes 35 papers. Separate abstracts were prepared for all papers. (J.F.P.)

For abstracts of individual papers see: 37680–37691, 37794, 37795, 37845–37863, 37892, and 37893.

Electromagnetic

Refer also to abstracts 37802 and 37908.

37735 (DESY-67/17) PHOTOPRODUCTION OF MULTIPION SYSTEMS. Satz, H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). May 1967. 7p. Dep.

Combining vector meson dominance and the quark model with isospin independence of production reactions above the resonance region, the cross sections for multipion photoproduction from the corresponding π-N data are predicted. (auth)

37736 SUM RULES FROM THE ALGEBRA OF FIELDS. Frishman, Y. (Stanford Linear Accelerator Center, Calif.). Phys. Rev. Lett., 19: 539-41(Aug. 28, 1967). (SLAC-PUB-322).

An additional sum rule for the spectral functions of the vector and axial-vector SU(2) ⊗ SU(2) gauge fields, is derived, and this sum rule is used to bring one more argument in support of the idea that the photon is coupled to the hadronic gauge fields, and not to the hadronic currents. (J.F.P.)

37737 LOW-ENERGY THEOREMS FOR SPIN $S \geq 1$. Pais, A. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 19: 544-6(Aug. 28, 1967).

Two new results for Compton scattering are noted: a relation for $S \geq 1$ which tests whether the total cross sections for unpolarized photons on a polarized stable target are asymptotically independent of the target polarization and the existence of low-energy theorems for all intrinsic multipole moments. The electric-quadrupole theorem is given explicitly. (auth)

37738 IS THE COSMOLOGICAL RED-SHIFT AN "AGING" OF PHOTONS? A SUGGESTED LABORATORY TEST. Shamir, J.; Fox, R. (Israel Inst. of Tech., Haifa). Nuovo Cim. (10), 50B: 371-2(Aug. 11, 1967).

The possibility of investigating the effect of the aging of light experimentally by the performance of a refined Kennedy–Thorndike-type experiment is suggested. (J.F.P.)

37739 HIGHER-ORDER DIFFERENCES IN MULTIPLE COULOMB SCATTERING. Dado, S.; Rosendorff, S. (Israel Inst. of Tech., Haifa). Nuovo Cim. (10), 50B: 238-55(Aug. 11, 1967).

In the framework of Molière's multiple Coulomb scattering theory the corrections due to correlation effects are calculated exactly. In particular the weight function which relates the single-scattering angles and the corresponding multiple-scattering angle, and Molière's parameter B are evaluated for every order of differences. The correlation coefficients ρ_{mn} (the ratio between the m-th and the n-th differences) are calculated as well, and relatively good agreement is found with experiment. Furthermore the standard deviation of the momentum-velocity product pv of the particle derived from the cosine function, first introduced by Lipkin et al., was calculated for every order of differences. It is found that it increases by about 8% per one order of difference. Arguments are put forward that the standard derivation of pv derived from other estimation functions, as for example the mean absolute angle, is at least as big as that derived from the cosine function. (auth)

37740 NONRESONANT π-π CONTRIBUTIONS TO ELECTROMAGNETIC FORM FACTORS. Antoniou, N. G.; Bowcock, J. E. (Univ. of Birmingham, Eng.). Phys. Rev., 159: 1257-62(July 25, 1967).

The effect of the exchange of two nonresonant pions on the electromagnetic structure of the pion and the nucleon is investigated. The results show that such an exchange is not negligible. By taking it into account, the value of the ρ mass needed to fit the nucleon isovector form factor may be changed from its previous anomalously low value to its experimental value. In addition, the coupling constant $g_{\rho NN}$, as deduced from the nucleon electromagnetic structure, is affected significantly. (auth)

37741 INTERFERENCE EFFECTS IN PHOTOPRODUCTION OF ρ^0 MESONS. Krass, Allan S. (Univ. of California, Santa Barbara). Phys. Rev., 159: 1496-1500(July 25, 1967).

A recently proposed model for the observed shift in the ρ^0 mass in photoproduction experiments is examined in detail. It is shown that if this model is correct, certain observable effects on the ρ^0 helicity density-matrix elements are predicted. Numerical predictions are made for some typical energies and production angles. (auth)

37742 EVALUATION OF THE DISPERSION RELATIONS OF PHOTOPRODUCTION. Finkler, Paul (Univ. of Nebraska, Lincoln). Phys. Rev., 159: 1377-86(July 25, 1967).

A modification of the Omnes method is used to solve the singular integral equations for the 3-3 partial-wave amplitudes of photoproduction. The effects of multipion production are assumed to be negligible. The method requires a knowledge of the phase at all energies. Consequently, it is necessary to treat the corresponding pion-nucleon scattering problem to determine the effect of the high-energy behavior of the phase on the solution for the scattering amplitude at low energies. The sharply resonant nature of the problem

suggests an approximation in the form of solution, rather than in the Born terms, which leads to relatively simple expressions for the ratios of the 3-3 photoproduction amplitudes to the scattering amplitude and for integrals involving the 3-3 amplitudes. In addition, a modified Chew-Low formula can be derived which should satisfactorily represent the 3-3 phase shift throughout the resonance regions. Finally, the cross sections are calculated in the 3-3 approximation and the results compared with experiment. (auth)

37743 POMERANCHUK-EXCHANGE CONTRIBUTION TO FORWARD PHOTON PROCESSES. Shepard, Harvey K. (Univ. of California, Santa Barbara). Phys. Rev., 159: 1331-5(July 25, 1967).

Assuming pure Regge-pole behavior and the crossing relations for helicity amplitudes, it is shown that (1) the Pomeranchuk trajectory does not contribute to Compton scattering from spin-0 or spin-$\frac{1}{2}$ particles in the forward direction; (2) Pomeranchuk exchange does contribute to forward vector-meson photoproduction, and at high energies the production of vector mesons with helicity ±1 dominates over the production of those with zero helicity. Some interesting properties of the crossing relations are derived and used to obtain these results. The difficulties associated with conclusion (1) are briefly discussed. (auth)

37744 HADRONIC CONTRIBUTIONS TO THE MUON MAGNETIC MOMENT. Kinoshita, T.; Oakes, R. J. (CERN, Geneva). Phys. Lett., 25B: 143-5(Aug. 7, 1967).

The extent to which the estimate of the hadronic contribution to the muon magnetic moment can be improved is examined using the most recent experimental information. (auth)

37745 CURRENT ALGEBRA AND SOME NON-STRONG MESONIC DECAYS. Sutherland, D. G. (CERN, Geneva). Nucl. Phys., B2: 433-40(1967).

A discussion is given of some radiative and isospin-violating decays of mesons in the framework of current algebra. In particular $\pi^0 \to 2\gamma$, $\omega \to \pi^0\gamma$, $\eta \to 2\gamma$, $\eta \to 3\pi$ are considered and the possible implications of some recent theoretical proposals and experimental results for these processes are discussed. (auth)

37746 INTERACTION OF NEUTRAL K AND ELECTROMAGNETIC FIELDS. II. $K_0-\bar{K}_0$ TRANSITIONS IN EXTERNAL FIELDS. Spitzer, Richard (Univ. of California, Livermore). Contract W-7405-eng-48. Nucl. Phys., B2: 479-500(1967). (UCRL-70231(Pt.2)).

The formulation of the presumed interaction of neutral K and electromagnetic fields developed in a previous paper is extended to include the effect of electric charges. The interaction of the electromagnetic field with both the neutral K and Dirac fields is discussed. The field equations for the system involving all three fields are derived and a proof of Lorentz covariance of the theory is given. The presumed interaction is shown to lead to $K_0-\bar{K}_0$ transitions in suitable configurations of external fields. The interaction that leads to the electromagnetic decay of the neutral pion is formulated from the same point of view as is taken with regard to the presumed interaction between neutral K and electromagnetic fields. (auth)

37747 RATIO BETWEEN THE AMPLITUDES OF PHOTOPRODUCTION AND PION–NUCLEON SCATTERING. Gurgenidze, V. S. (Tbilisi State Univ., USSR). Soobshch. Akad. Nauk Gruz. SSR, 46: 61-5(Apr. 1967). (In Russian).

Previously M. Morascsik (Phys. Rev. 125: 1088, 1962) showed that at energies below the photoproduction threshold of two π mesons the conditions for S-matrix tie the amplitudes of π meson photoproduction on nucleon with the pion–nucleon scattering amplitudes. Consequently, it is possible to determine all eight independent virtual functions or to determine all four complex amplitudes when the amplitudes of pion–nucleon scattering are known. An attempt was made to use the conditions for S-matrix unitarity in order to obtain the integral relations between the amplitudes of photoproduction processes and pion–nucleon scattering. The photoproduction processes of $\gamma + P \to \pi^0 + P$ and $\gamma + P \to \pi^+ + n$ and scattering processes of: $\pi^0 + P \to \pi^0 + P$, $\pi^+ + n \to \pi^+ + n$, $\pi^0 + P \to \pi^+ + n$, $\pi^+ + n \to \pi^0 + P$ are analyzed. (R.V.J.)

37748 REMARKS ON THE NUCLEON MASS DIFFERENCE. Rix, J. (Case Inst. of Tech., Cleveland). Phys. Rev., 158: 1600-7(June 25, 1967).

The current, contradictory status of the nucleon mass difference is examined. It is argued that the sign and order of magnitude of the mass difference cannot be established without considering the strong interactions in some detail. An explicit calculation of ΔM using the static model in low orders of the strong coupling illustrates that while the usual Feynman self-energy graph gives the wrong sign for ΔM, there is another low-order contribution with the correct sign and order of magnitude to produce the observed ΔM. This contribution is similar to a Schrödinger bound-state spin-orbit perturbation but with the opposite sign than what one would expect on the basis of semiclassical arguments. The Dashen–Frautschi dispersive approach and reactive calculations by Pagels and also Fried and Truong are briefly discussed in light of these observations. (auth)

37749 DECAYS $\pi^0 \to 2\gamma$, $\eta \to 2\gamma$ AND SUM RULES FOR NUCLEON COMPTON SCATTERING. Pagels, Heinz (Rockefeller Univ., New York). Phys. Rev., 158: 1566-76(June 25, 1967).

Motivated by the success of the Goldberger–Treiman calculation of charged-pion decay and the assumption of pion-pole dominance of the divergence of the axial current subsequently introduced, we study the decays of the neutral pion and eta in the same way. Examining Compton scattering of real photons from the nucleons presents a fruitful analogy to the nuclear β-decay process. Identifying the dominant nucleon and meson-pole-term contributions to Compton scattering and utilizing the content of the exact low-energy theorem on Compton scattering, a no-subtraction hypothesis, supported by the Regge-pole phenomenology, then enables us to establish exact sum rules for the lifetimes $\tau_{\pi^0\to 2\gamma}$ and $\tau_{\eta\to 2\gamma}$ and also the Drell–Hearn sum rules for $\kappa_p^2 \pm \kappa_n^2$. We also consider in detail the relation of our sum rule to the Goldberger–Treiman calculation of π^0 decay and forward-Compton-scattering sum rules for systems of spin = 1. Neglecting continuum contributions, which are small, we find from our sum rules $\kappa_p^2 = \kappa_n^2$ and $\tau_{\pi^0\to 2\gamma}^{-1} = \pi\alpha^2 m_\pi^3 \kappa_p^2/4g_{\pi N}^2 M_N^2 \simeq 3.1$ eV or $\tau_{\pi^0\to 2\gamma} \simeq 2.2 \times 10^{-16}$ sec in approximate agreement with the experimental value $\tau_{\pi^0\to 2\gamma} = (1.0 \pm 0.5) \times 10^{-16}$ sec. Better photopion-production data for the nonresonant multipoles would enable us to accurately estimate the continuum contributions. Including the dominant contributions to the photopion production continuum, we find that the Drell–Hearn sum rule for $\kappa_p^2 + \kappa_n^2$ is well satisfied. We can estimate the $\eta \to 2\gamma$ lifetime but our result depends on a knowledge of the eta-nucleon coupling and on nonresonant background contributions to the photopion multipoles. Once better photopion production data for the resonant multipoles $E_{l\pm}$, $M_{l\pm}$, $l \leq 2$ for energies <1 BeV become available, these sum rules can offer reliable theoretical estimates for the decays $\pi^0 \to 2\gamma$, $\eta \to 2\gamma$. (auth)

37750 ELECTRODISINTEGRATION OF THE DEUTERON. I. CONNECTION BETWEEN THE n–p–d VERTEX FUNCTION AND THE DEUTERON WAVE FUNCTION. McGee, Ian J. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev., 158: 1500-14(June 25, 1967). (COO–881-94).

Higher-order relativistic corrections to the Durand theory for the electrodisintegration of the deuteron are considered, based on the Mandelstam representation for the transition matrix element. The analysis concentrates on the kinematical region corresponding to the broad quasi-elastic peak in the cross section $d^2\sigma/d\Omega_e de_0'$, where e_0' is the final electron energy. The presence of anomalous thresholds and the close connection between the nonrelativistic wave functions and the spectral functions in the anomalous region allow the relativistic expression to be recast in terms of ostensibly nonrelativistic wave functions. The calculation is facilitated by separating the neutron-proton-deuteron vertex function into angular momentum components corresponding to momentum-space wave functions. The result clarifies the role of certain off-mass-shell effects, particularly those contributions which involve antiparticles in the intermediate state. The antiparticle contributions are found to be small for $q^2 \lesssim 0.8$ $(\text{BeV}/c)^2$. The cross sections $d^2\sigma/d\Omega_e de_0'$ and $d^3\sigma/d\Omega_e de_0' d(\cos\theta)$ are presented in first Born approximation but the detailed inclusion of the effects of final-state interactions on the cross sections is reserved for a subsequent paper. (auth)

37751 IMPLICATIONS OF REGGE BEHAVIOR FOR PROCESSES INVOLVING PHOTONS. Abarbanel, Henry D. I.; Nussinov, S. (Princeton Univ., N. J.). Phys. Rev., 158: 1462-6 (June 25, 1967).

Properties of the crossing matrix for helicity amplitudes are enumerated and then exploited in a simple Regge-pole model of photon-hadron interactions. It is found that: (1) The vacuum or Pomeranchuk trajectory is absent in forward Compton scattering of real photons on nucleons or pions. Thus the total nuclear cross section for photons or nucleons should vanish asymptotically. (2) The amplitudes entering the forward spin-flip Compton scattering of virtual photons on protons, which are crucial in the proton structure contributions to the ground-state hyperfine splitting (hfs) in hydrogen, may be chosen so that they do not require a subtraction when writing dispersion relations for them in the energy variable. One must look elsewhere than to the high-energy behavior of the amplitudes for the erasure of the discrepancy between theory and experiment on the hfs. (3) In forward photoproduction of vector mesons on protons, the polarization of the mesons should be predominantly longitudinal at "high energy." (4) In the differential cross section $d\sigma/dt$ for photoproduction of

neutral pions, there should be a dip at $t \approx -0.5$ BeV^2 because of a nonsense zero in all crossed-channel helicity amplitudes. (auth)

37752 PHOTOPRODUCTION OF MULTIPION SYSTEMS. Satz, H. (DESY, Hamburg). Phys. Lett., 25B: 27-9(July 24, 1967).

Combining vector meson dominance and quark model with isospin independence of production reactions above the resonance region, the cross sections for multipion photoproduction are predicted from the corresponding π-N data. (auth)

37753 SOME CONSEQUENCES OF THE POSSIBLE MODIFICATIONS OF QUANTUM ELECTRODYNAMICS. Fitelson, Michael; Kazes, Emil (Pennsylvania State Univ., University Park). Phys. Rev., 158: 1537-40(June 25, 1967).

To separate electron from proton form factors in electron-proton scattering experiments requires the measurement of spin-dependent effects such as polarization transfer, depolarization, etc. To find which of these measurements is most critically affected by the structure of the electron, the final-state electron-beam and proton-target polarizations for the one-photon-exchange scattering of a polarized beam and initially unpolarized target, and the converse situation, were calculated. (auth)

Weak

Refer also to abstracts 37671, 37774, 37775, and 37819.

37754 NEUTRINO VISCOSITY AND THE ISOTROPY OF PRIMORDIAL BLACKBODY RADIATION. Misner, Charles W. (Cambridge Univ., Eng.). Phys. Rev. Lett., 19: 533-5(Aug. 28, 1967).

Viscosity due to the long mean free paths of electron neutrinos in the primordial fireball just before $e-\nu_e$ scattering stops at 10^{10}°K reduces any homogeneous anisotropy in the expansion of the universe to a level which does not effect the expansion rate significantly thereafter. (auth)

37755 THEORY OF THE MASS SPECTRUM OF ELEMENTARY PARTICLES WITH THE FINE STRUCTURE BEING TAKEN INTO ACCOUNT. Akulov, N. S. (Div. of Physics of Nondestructive Testing, Minsk). Dokl. Akad. Nauk BSSR, 11: 107-11 (Feb. 1967). (In Russian).

The mass of a neutrino (or of a reon which is an excited neutrino) is given by the following expression on interaction with other neutrinos in muons and pions: $m_\nu = 35 + (0.511 + m_\epsilon g^2)\,\epsilon^2 - \delta$. Here g is a "gravitation" quantum number, and ϵ is the charge quantum number. At $\epsilon = 0$ and $g = 0$ the neutrino is free, and its rest mass is zero. At $\epsilon = 1$ and $g = 0$ the neutrino is converted to an electron (mass $m_e = 0.511$ MeV), and the antineutrino is converted to a positron. At $\epsilon = 0$ and $g = 1$ the neutrino has a mass m_g equal to 35 MeV theoretically. The value of m_ϵ above is the additional value due to interaction between particles. At very small distances between reons (bound neutrinos in muons and pions), $\delta = \delta_1 = \text{const}$. The neutrino mass depends on its quantum state. The mass of a muon was calculated to be 105.85 MeV by the above formula, while the experimental value is 105.66. The mass of a heavy neutral pion, which is a constituent part of kaons, was found to be 144.28 MeV by the above formula. It is shown that the masses of hadrons consists of the masses of muons, pions and bosons with the mass defects being taken into account, which determine the binding energy of reons in muons and pions, and also the binding energy of these mesons in other elementary particles Thus, it is found that $M(K^\pm) = M(\mu^+\mu^-\pi^\pm\pi_s) = 493.98$ MeV which is in good agreement with the experimental value of 493.8 MeV. Also $M(K^0) = M(\mu^+\mu^-\pi_1\pi^+W_s^-) = 497.7$ MeV which agrees well with the experimental value of 497.9. (TTT)

37756 NEW APPROACH TO ALGEBRA OF CURRENTS AND APPLICATION TO $K \to 2\pi$ DECAY. Okubo, S.; Marshak, R. E.; Mathur, V. S. (Univ. of Rochester, N. Y.). Phys. Rev. Lett., 19: 407-10(Aug. 14, 1967). (UR-875-200)

Ambiguities arising in some applications of current algebra are overcome by employing the algebra of currents to calculate the subtraction constant in a once-subtracted dispersion relation. The new approach is applied to $K \to 2\pi$ decay and yields corrections to the usual current-algebra method of about 10%. The branching ratio $(K^+ \to \pi^+ + \pi^0)/(K_1^0 \to \pi^+ + \pi^-)$ is also computed and agrees well with experiment. (auth)

37757 ANALYSIS OF K_{l3} FORM-FACTOR DATA. Auerbach, L. B.; Mann, A. K.; McFarlane, W. K. (Univ. of Pennsylvania, Philadelphia). Contract AT(30-1)-2171. Phys. Rev. Lett., 19: 464-7(Aug. 21, 1967). (NYO-2171-223).

The data available for determining the ratio of the form factors, $\xi(q^2) = f_-(q^2)/f_+(q^2)$, that describe the hadron current in the decays $K \to \pi^+$ lepton $+\nu$ are analyzed. The momentum transferred to the meson (π) is denoted by $q^2 = M_K^2 + m_\pi^2 - 2M_K E_\pi$. It is shown in the approximation that $f_+(q^2)$ vary linearly with q^2, a consistent interpretation of all present K_{l3} data requires a q^2 dependence of f_- which is an order of magnitude greater than that of f_+. (J.F.P.)

37758 DETERMINATION OF RELATIVE SIGN OF AMPLITUDES IN Λ^0 DECAY. Overseth, O. E. (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett., 19: 395-7(Aug. 14, 1967).

It is shown how the relative sign of the $p\pi^-$ and $n\pi^0$ amplitudes can be experimentally determined by observing the effects of the strong interaction in free Λ^0 decay, namely in the final-state interaction between the outgoing nucleon and pion. The results indicate that the required admixture of $\Delta I = \frac{1}{2}$ and $\frac{3}{2}$ which duplicates the predictions of the $\Delta I = \frac{1}{2}$ rule does not occur. (L.B.S.)

37759 TIME REVERSAL INVARIANCE IN Λ^0 DECAY. Overseth, O. E. (Univ. of Michigan, Ann Arbor); Roth, R. F. Phys. Rev. Lett., 19: 391-3(Aug. 14, 1967).

The decay parameters of $\Lambda^0 \to p + \pi^-$ were determined to be $\alpha = +0.65 \pm 0.02$, $\beta = -0.10 \pm 0.07$, $\gamma = +0.75 \pm 0.02$. Under time-reversal invariance, $\beta/\alpha = -\tan(\delta_s - \delta_p)$, where δ_s and δ_p are appropriate pion-nucleon scattering phase shifts; from this experiment $\beta/\alpha = -0.16 \pm 0.10 = -\tan(9° \pm 5.5°)$ in good agreement with the known value of $(\delta_s - \delta_p) = 6.5° \pm 1.5°$. (auth)

37760 $K_{\mu 3}$ AND K_{e3} FORM FACTORS AT FINITE MOMENTUM TRANSFER. Fitelson, M.; Kazes, E. (Pennsylvania State Univ., University Park). Phys. Rev., 159: 1236-8(July 25, 1967).

The first-moment operator of the SU(3) current algebra is approximated by requiring that it only induces transitions in or out of the pseudoscalar meson octet. The functional form of the resultant K to π form factors are then calculated in a closed form. (auth)

37761 CURRENT ALGEBRAS AND MESON FORM FACTORS. Lai, Chai Shing (Univ. of Chicago). Contract AT(11-1)-264. Phys. Rev., 159: 1404-21(July 25, 1967). (COO-264-369; EFINS-67-12).

Relations between the weak form factors of mesons are derived by employing the following methods of current algebras: (a) the Oehme approximation without Hamiltonian, (b) saturation of commutators by allowed single-particle and disconnected pair states, (c) the Ward-Takahashi method, and (d) the generalized Ward-Takahashi method with the hypothesis of partially conserved axial-vector current (PCAC). These relations of meson form factors in various limits and their pole-model solutions are then discussed and compared. The information about meson form factors thus extracted indicates that the renormalization effects are small and the suppression of the $|\Delta S| = 1$ semileptonic decays cannot be due to the symmetry-breaking effects. It is shown that the generalized Ward-Takahashi method with the PCAC hypothesis and the Ward-Takahashi method alone give equivalent results, as far as the meson vertex functions of the conserved vector currents are concerned. However, in the case of nonconserved currents, there are important differences involving contributions from possible scalar mesons. Within the framework of pole models, it is found that the methods (a) and (d), and the methods (b) and (c), give equivalent results. (auth)

37762 DYNAMICAL MODEL FOR THE HYPERON NONLEPTONIC DECAY. Watanabe, Keiji (Dublin Inst. for Advanced Studies). Phys. Rev., 159: 1369-73(July 25, 1967).

A bootstrap calculation is performed for the nonleptonic hyperon decays. These decays can be reduced to the scattering processes: spurion + baryon → pion + baryon. On the assumption that the spurion has nonvanishing energy and momentum, the partial-wave decomposition is performed. The *f*/d ratio for the weak and the strong interaction is obtained from the self-consistency condition by using Nishijima and Swank's weak Hamiltonian. By taking the spurion momentum equal to zero, S- and P-wave amplitudes are calculated. The agreement with experiment is satisfactory. (auth)

37763 CURRENT ALGEBRA AND K_{l3} FORM FACTORS. Iliopoulos, J.; Van Royen, R. P. (CERN, Geneva). Phys. Lett., 25B: 146-8(Aug. 7, 1967).

Using current algebra and a "smoothness" hypothesis a small value of f_- in K_{l3} decay is predicted. (auth)

37764 METHOD OF DETERMINING ANGULAR MOMENTA OF NUCLEAR EXCITED STATES. Willmes, Henry. Res. Rev. (Office Aerosp. Res.), 6: No. 5, 16-20(May 1967).

The algebraic method for the description of strong and weak interactions is reviewed. The developments leading to the formulation of this method are discussed starting from quantum electrodynamics. (J.F.P.)

37765 THREE-BODY PHOTONIC DECAY OF HYPERONS AND ALGEBRA OF CURRENTS. Ghielmetti, F.; Iwao, S. (Univ., Bern). Helv. Phys. Acta, 40: 525-30(1967).

The three-body photonic decay of hyperons is studied in the

framework of quantum field theory under the hypotheses of the algebra of currents and the soft pion limit. The transition amplitude under consideration can be expressed by the two-body hadronic and photonic decay ones. The main contribution arises from the p-wave hadronic as well as the corresponding photonic decay amplitudes which allows examination of these amplitudes in comparison with the experimental information on three-body photonic decays. For this purpose the relative as well as the absolute rate of the charged and the neutral pion associated decays and the decay asymmetry parameter are calculated. The method presented will give a tool for clarifying the present experimental and theoretical ambiguities of two-body hadronic decay amplitudes. (auth)

37766 ON NEUTRAL LEPTON CURRENTS IN A NEW CP-ODD, $|\Delta S| = 1$, ULTRAWEAK INTERACTION OF FUNDAMENTAL PARTICLES. Lipmanov, E. M. (Volgograd State Pedagogical Inst., USSR). Zh. Eksp. Teor. Fiz., 53: 254-7(July 1967). (In Russian).

A simple model for a new CP-odd, $|\Delta S| = 1$, ultraweak interaction of fundamental particles is proposed as the product of neutral currents. Possible unitary and isotopic properties of the interaction for nonlepton processes are discussed as well as possible experimental manifestations of it in presence of neutral lepton currents. (auth)

37767 ELECTROMAGNETIC WEAK DECAYS IN THE NISHIJIMA MODEL. Mani, H. S.; Tomozawa, Yukio; Yao, York-peng (Univ. of Michigan, Ann Arbor). Phys. Rev., 158: 1577-9 (June 25, 1967).

Using a model proposed by Nishijima and collaborators, various weak radiative decays of baryons and mesons are discussed. Under the assumption of pole dominance, interesting predictions are found which are in general different from those of other models. (auth)

37768 $K_2^0 \to \pi^0 + 2\gamma$ DECAY. Oneda, S. (Univ. of Maryland, College Park). Phys. Rev., 158: 1541-3(June 25, 1967).

It is pointed out that if the experimentally reported large branching ratio of $\eta^0 \to \pi^0 + 2\gamma$ decay is indeed correct, it may also suggest a large branching ratio for the $K_2^0 \to \pi^0 + 2\gamma$ decay. The closeness of the masses of the K^0 meson and the η^0 meson, together with this unexpectedly large coupling constant of the $\eta^0 \to \pi^0 + 2\gamma$ decay implies that the diagram $K_2^0 \to \eta^0 \to \pi^0 + 2\gamma$ may lead to a relatively large branching ratio of the $K_2^0 \to \pi^0 + 2\gamma$ decay, contrary to our usual expectation. Simple calculation based on the pole model with the SU(3) symmetry indicates that the frequency of this mode is at least comparable with or may even be larger than that of $K_2^0 \to 2\gamma$ decay. Furthermore, since both the $K_2^0 \to 2\pi^0$ and the $K_2^0 \to \pi^0 + 2\gamma$ decays are essentially 4γ processes, the decay $K_2^0 \to \pi^0 + 2\gamma$ could constitute an important background for the $K_2^0 \to 2\pi^0$ experiments if its rate is comparable with that of $K_2^0 \to 2\pi^0$ decay. Some kinematical features of this decay are also discussed. (auth)

37769 NONLEPTONIC HYPERON DECAY AND BARYON-WEAK-HAMILTONIAN COMMUTATORS. Fenster, S. (Argonne National Lab., Ill.); Panchapakesan, N. Contract AT(11-1)-264. Phys. Rev., 158: 1382-5(June 25, 1967). (COO-264-389).

The amplitude for the nonleptonic decay of hyperons is expressed in terms of an absorptive part and an equal-time commutator of the baryon field with the weak Hamiltonian. The assumption that the parity-conserving and parity-violating parts of the weak Hamiltonian transform like scalar (S_4) and pseudoscalar (S_4^5) quantities, respectively, enables the commutator to be evaluated. The absorptive parts are calculated under the assumption that they are dominated by single-particle states. The assumption that S_4^5 and the strong pseudoscalar vertex belong to the same octet when combined with the experimental observation that A (Σ_+^+) = 0 enables the calculation of d/f for this octet. The value obtained is $\sqrt{3}$, which is in excellent agreement with the value obtained from leptonic decays. The results for p waves are not so definite, but indicate a dominant d-type coupling. (auth)

37770 AMBIGUITY IN SOFT-PION EXTRAPOLATION, NONLEPTONIC DECAYS AND THE $\eta \to 3\pi$ DECAY. Mathur, V. S. (Univ. of Rochester, N. Y.). Contract AT(30-1)-875. Nuovo Cim. (10), 50A: 661-4(Aug. 1, 1967). (UR-875-172).

It is shown that there exists a large class of Hamiltonians which lead to equivalent results for matrix elements on the mass shell, but extrapolate differently for soft mesons (π). It is further shown how this freedom can be exploited in order to reach a solution for the problems of describing the p-wave nonleptonic hyperon decays, where the prediction of the decay amplitudes by current algebra techniques is too small by a factor of about two compared with the experimental results, and the calculation of the decay $\eta \to 3\pi$, where the same technique correctly describes the $K \to 3\pi$ decays but leads to a vanishing result for $\eta \to 3\pi$. (J.F.P.)

37771 NONLEPTONIC K-DECAYS AND THE WEAK ISOSPIN SPACE. Brunet, R. C. (Syracuse Univ., N. Y.). Nuovo Cim. (10), 50A: 562-7(Aug. 1, 1967).

In the current × current theory $K \to 2\pi$ decays are allowed only if SU_3 is broken. Such a theory which is free of parameters and gives the small ratio $K^+ \to 2\pi/K_1^0 \to 2\pi$ without assuming octet dominance is formulated. The theory is analogous to the schizon theory and makes use of the rotated triplet of isovector currents. (auth)

37772 FINITENESS OF RADIATIVE CORRECTIONS TO $\pi\beta$-DECAY. Cabibbo, N. (CERN, Geneva. Univ., Rome); Maiani, L.; Preparata, G. Phys. Lett., 25B: 31-4(July 24, 1967).

It is shown that the radiative corrections to π-β-decay are finite if a sum rule involving weak and e. m. transitions for π's is satisfied. The sum rule is evaluated in the vector meson dominance hypothesis and found to predict $\Gamma(\omega \to \pi\gamma)$ and $\Gamma(\pi^0 \to \gamma\gamma)$ in good agreement with the experimental data. Some comments are made on the possible general cancellation of the divergences in the radiative corrections to β-decay. (auth)

Strong (General)

Refer also to abstract 37764.

37773 (COO-1428-28) THEORETICAL STUDY OF INTERACTION OF ELEMENTARY PARTICLES. Progress Report, February 1, 1967-May 31, 1967. Sugawara, Masao (Purdue Univ., Lafayette, Inc. Dept. of Physics). July 12, 1967. Contract AT(11-1)-1428. 12p. Dep. CFSTI.

A summary of the research carried out, which consists of the completion of a comprehensive review of nonleptonic weak interactions and the initiation of research into infinite-component wave equations, is given. (J.F.P.)

37774 (CTS-HE-67-4) DYNAMICAL THEORY OF BARYONS AND LEPTONS. Kursunoglu, Behram (Miami Univ., Coral Gables, Fla. Center for Theoretical Studies). July 1967. 48p.

An attempt is made to give a dynamical description of baryons and leptons by the same wave equation yielding different mass spectra for each one of them. By using a classical nonlinear (Born-Infeld type) Lagrangian depending on the field variables E and H, a wave equation for spin $\frac{1}{2}$ and $\frac{3}{2}$ particles is derived. In this approach the field itself is treated as a wave function and therefore a way is found to get rid of Born type square root. The wave equation involves, besides Dirac matrices, the 15 six-dimensional generators of the group SU(3,1). It is invariant under $G = SL(2,C) \times SU(3,1) \times L$ transformations, where the semi-direct product contains the Lorentz group L. The wave equation yields the following results: mass spectra for leptons and baryons in the form of singlets and doublets, a third neutrino along with a third neutral lepton, in addition to electron and muon, are predicted, difficulties of negative probabilities usually associated with half integral higher spin theories do not arise. (auth)

37775 (ISS-67/13) RADIATIVE CORRECTIONS TO LEPTONIC DECAYS AND COMPOSITE MODELS FOR STRONG INTERACTIONS. Cabibbo, N.; Maiani, L.; Preparata, G. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). June 11, 1967. 11p. Dep.

On the basis of the requirement of finite radiative corrections for leptonic decays the abondonment of the quark model for strong interactions in favor of models based on integrally charged triplets is proposed. A model of this kind — the SUB model —, based on a proposal of Han and Nambu in which most of the results of the nonrelativistic quark-model hold, is discussed. (auth)

37776 (UCR-34P107-49) [PARTICLE PHYSICS]. Annual Report. Kaus, Peter E.; Desai, B. R. (California Univ., Riverside). May 1967. Contract AT(11-1)-34. 23p. Dep. CFSTI.

A summary of the research both completed and in progress at the University of California, Riverside, is presented. This research concerns the various theoretical properties of hadron interactions and decays, and use is made of Regge pole and S-matrix theory, and current algebra. (J.F.P.)

37777 QUARK MODEL AND QUADRATIC MASS FORMULAS FOR MESONS. Ishida, Shin; Roman, P. (Boston Univ.). Phys. Rev., 159: 1365-8(July 25, 1967).

Within the framework of the nonrelativistic quark model, a simple field-theoretical prescription is given for using quadratic mass formulas for all mesons and linear mass formulas for all baryons. It is postulated that the unperturbed part of the quark-system Hamiltonian possesses SU(6) symmetry with respect to the spin and unitary spin of the constituent quarks. Quadratic mass relations within meson multiplets as well as quadratic electromagnetic mass relations are derived, and it is shown that the parameters can be

uniquely fitted to experiment, avoiding the serious discrepancy which exists when such a fit is attempted in the standard quark-model framework which uses linear mass relations. (auth)

37778 QUARK MODEL FOR BARYON–BARYON PROCESSES. Das Gupta, Sutapa; Mitra, A. N. (Univ. of Delhi). Phys. Rev., 159: 1285-91(July 25, 1967).

A quark (Q) model recently proposed for high-energy meson-baryon and photoproduction processes is extended to high-energy baryon-baryon scattering and production of negative-parity baryons. The positive- and negative-parity baryons are assumed to belong, respectively, to the representations (56,1) and (70,3) of the group SU(6) × O(3). Sum rules resembling those of SU(3) and SU(6,6), but differing in details, are obtained for the baryon-baryon processes within the 56 representation. An interesting sum rule which is obtained for negative-parity baryon production involves only nonstrange particles and could be within fairly early reach of experiment. The model is primarily characterized by an impulse approximation for Q-Q scattering and thus disallows processes involving exchanges of more than one unit of charge, hypercharge, and even spatial symmetry, among the initial and final 3Q states representing the baryons. This last condition precludes the high-energy peripheral production of metastable baryon states like the Roper resonance, which we believe to have an internal orbital structure of $L^P = 1^+$. (auth)

37779 GEOPHYSICAL ASPECTS OF THE SEARCH FOR THE QUARK. Nir, A. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev. Lett., 19: 336-9(Aug. 7, 1967).

The suitability of natural media to serve as objects of analysis for quark abundance, including the effects of momentum distribution at production, concentration or dilution in collection, effective length of irradiation by cosmic radiation, and target shape is discussed. The resulting concentrations may vary by ten orders of magnitude, the lowest being for sea water, the highest for stratospheric aerosols and selected iron meteorites. (auth)

37780 RADIATIVE CORRECTIONS TO LEPTONIC DECAYS AND COMPOSITE MODELS FOR STRONG INTERACTIONS. Cabibbo, N. (CERN, Geneva. Univ., Rome); Maiani, L.; Preparata, G. Phys. Lett., 25B: 132-5(Aug. 7, 1967).

On the basis of the requirement of finite radiative corrections for leptonic decays, the abandonment of the quark model for strong interactions in favor of models based on integrally charged triplets is proposed. A model of this kind—the SUB model based on a proposal of Han and Nambu—is discussed in which most of the results of the non relativistic quark-model hold. (auth)

37781 PRESENT EXPERIMENTAL STATUS AND FUTURE PROSPECTS OF HYPERNUCLEAR PHYSICS. Davis, D. H. (London Univ.); Sacton, J. Univ. Brux., Inst. Phys., Bull., No. 34, 1-18(June 1967).

Recent results from the study of hypernuclei concerning the weak and strong interactions of hyperons (Λ) with nucleons, and the ability of a hyperon (Λ) to bind an unstable core nucleus and the final-state interactions occurring between the products of hypernuclear decays are summarized. Also future prospects of hypernuclear studies are outlined. Binding energy determinations, the meson (π^+) decay of light hypernuclei, ΛΛ hypernuclei, and hypernuclei and nuclear physics are discussed. (J.F.P.)

37782 MASS SPLITTING AND THE QUARK THEORY. I. Umezawa, M. (Institut de Recherches Nucleaires, Strasbourg). Phys. Rev., 158: 1385-90(June 25, 1967).

The masses of the decuplet and the octet baryons are calculated by using a spin- and SU(3)-spin-dependent quark-quark force. It is compared with the required quark-antiquark force used in a previous paper in order to explain the mass splitting of the P and the V nonet mesons. The result is consistent with the assumption that these two forces are related to each other by charge conjugation. It is observed that the ratio of radial integrals for quark-quark and quark-antiquark symmetry-breaking forces is the same as that for the symmetric forces, if quarks are very heavy. (auth)

37783 REGGE-QUARK MODEL OF HADRON SCATTERING. James, P. B.; Logan, R. K. (Univ. of Illinois, Urbana). Phys. Lett., 25B: 38-40(July 24, 1967).

It is shown that a general agreement of the Regge quark model with total cross section data for hadron–hadron interactions can be obtained by comparing the hadron amplitudes at equal relative velocity. The model is also used to fit the recently measured values of ReA/ImA for $\pi^{\pm}$p and pp interactions. (L.B.S.)

Strong (Baryon No. = 0)

37784 SATURATION PROBLEM OF A SUM RULE OF SCALAR AND PSEUDOSCALAR SPECTRAL FUNCTIONS. Woo, C. H. (Univ. of Maryland, College Park). Phys. Rev. Lett., 19: 537-9(Aug. 28, 1967).

A sum rule of the scalar and pseudoscalar spectral functions is studied as a possible test for the commutation relations between the fourth component of the axial-vector current and the scalar and pseudoscalar densities. Approximating the spectral functions by the one-pion and two-pion contributions, one finds the sum rule to be badly violated. (auth)

37785 ASYMPTOTIC SU(3) AND VECTOR MESON DECAYS. Das, T.; Mathur, V. S.; Okubo, S. (Univ. of Rochester, N. Y.). Contract AT(30-1)-875. Phys. Rev. Lett., 19: 470-3 (Aug. 21, 1967). (UR-875-206).

Several sum rules based upon the assumption that the SU(3) group will be exact at infinite energy are derived. In this way, decays of vector mesons into lepton pairs were computed together with the decay rate for $\varphi \to K\bar{K}$. (auth)

37786 SUPERCONVERGENCE RELATIONS FOR MESONS AND HIGHER SYMMETRIES. Oehme, Reinhard; Venturi, Giovanni (Univ. of Chicago). Contract AT(11-1)-264. Phys. Rev., 159: 1283-5(July 25, 1967). (COO-264-366; EFINS-67-4).

Superconvergence relations for meson-meson scattering are obtained on the basis of locality and unitarity, and they are selected using the infinite-momentum limit. Complete saturation of these superconvergence relations with nonets of pseudoscalar and vector mesons gives rise to a consistent set of relations between coupling constants. These equations have a unique solution which is consistent with collinear U(6) symmetry for the vertices. It is proposed that this result remains unchanged if additional intermediate states are introduced in sets corresponding to higher representations of U(6) ⊗ U(6) ⊗ O(3) which separately satisfy the relations. (auth)

37787 RESONANCE SATURATION OF AXIAL CHARGE COMMUTATORS, SU(3) SYMMETRY, AND SCALAR MESONS. Matsuda, S.; Oneda, S.; Sucher, J. (Univ. of Maryland, College Park). Phys. Rev., 159: 1247-50(July 25, 1967).

Resonance saturation of axial charge commutators taken between states of the pseudoscalar-meson octet is examined and found to be strongly suggestive of the existence of a 0^+ octet and a 0^+ singlet in the 500- to 1000-MeV region. The vector-meson contribution to the matrix element of the vector current taken between K and π states is shown to give only 50% or so of the experimental value, in contrast to the conclusions of other authors, but in agreement with general SU(3) considerations and the estimate of Adler of the ρ contribution to the sum rule for the π–π scattering. The approach to π_{e3} decay based on dispersion theory and charge-current commutators already used by Marshak et al., for K_{e3} decay is shown to give good agreement with experiment if vector-meson dominance is assumed. It is pointed out that in both cases the resulting expressions for the form factors at zero momentum transfer differ exactly by a factor of 2 from the corresponding ones obtained in the approach using only commutators of charges. (auth)

37788 EXTERNAL MASS CONTINUATION AND COMMUTATION RELATIONS IN π-π SCATTERING. Meiere, F. T. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 159: 1462-70(July 25, 1967).

Single-variable, subtracted dispersion relations in the external mass and energy are used to calculate the difference between the π-π amplitude evaluated at physical threshold and at the unphysical zero point which occurs in the application of current-algebra techniques. All differences are relatively small. For one of the amplitudes this is in disagreement with the result obtained using expansion techniques. Further, the pseudoscalar density commutator, which lies outside the $SU_3 \times SU_3$ algebra, is evaluated from a model using only conventional fields. The resulting current-algebra relations differ from those given by the quark model. However, the scattering lengths obtained, $a_0 = +0.18$ and $a_2 = -0.04$, are consistent with those obtained by Weinberg using expansion techniques together with the quark model. This appears to be nontrivial, since our mass extrapolation and quark-model commutation relations for the pseudoscalar density give a different result, $a_0 = +0.05$, $a_2 = -0.09$. The π-π sum rule involving an unsubtracted dispersion relation is evaluated. The ρ meson gives the dominant contribution, in contrast to the subtracted dispersion integrals where it gives only minor contributions. Crossing symmetry implies large background contributions from the ρ in the crossed channel and when these are taken into account, the sum rule is approximately satisfied with our scattering lengths. (auth)

37789 QUARK MODEL FOR BARYON–ANTIBARYON PROCESSES. Das Gupta, Sutapa (Univ. of Delhi). Phys. Rev., 159: 1345-7(July 25, 1967).

A recently proposed quark (Q) model treating positive-parity and

negative-parity baryonic states as 3Q composites belonging to the $(56,1)^+$ and $(70,3)^-$ representations of SU(6) × O(3), respectively, is extended to baryon-antibaryon processes. Both one and two units of ΔS, ΔQ, ΔI exchange processes are considered through single and double pair scattering of quarks by antiquarks. Apart from reproducing the SU(3) results, a number of new relations similar to those obtainable from higher symmetries are derived for the cross sections of inelastic processes, in fair agreement with available experimental data. (auth)

37790 BOSON MASSES. II. Peaslee, D. C. (Australian National Univ., Canberra). Phys. Rev., 159: 1335-9(July 25, 1967).

The baryon-antibaryon model is employed to attempt a complete empirical assignment for the boson nonets with orbitals $^1S_0$, $^3S_1$, $^1P_1$, $^3P_0$, $^3P_1$, $^3P_2$. Only one state seems to be missing experimentally, and a search area is indicated by a simple degeneracy in the model. Some substantial level shifts are proposed to result from open channels for multiboson decay; with these can be associated the possibility of reduced ω-φ mixing. The octet SU_3 mass formula appears to be valid for only the $^1S_0$ nonet; a generalized formula reflects major R_7 and minor G_2 mixing with the basic SU_3. For K- and η-type mesons the triplet orbitals display strong tensor as well as spin-orbit splitting. As a consequence the K*(1400) should be a mixture of $2^+(^3P_2)$ and $1^-(^3D_1)$ resonances, with respective dominant modes Kππ and Kπ. Some remarks are added about D states and the validity of A parity. (auth)

37791 SOME REMARKS ON SUPERCONVERGENCE RELATIONS. Choudhury, S. Rai; Nussinov, S. (Princeton Univ., N. J.). Phys. Rev., 159: 1324-7(July 25, 1967).

Possible superconvergence sum rules are investigated for meson-baryon and baryon-antibaryon scattering. For meson-baryon systems, two simple procedures involving differentiation with respect to t at t = 0 are presented, and the explicit subtraction of leading Regge-pole contributions is discussed and applied to π-Σ and π-$\underline{N}$ systems. Finally, superconvergence relations are written for backward $\underline{N}$-$\bar{N}$ scattering and obtain sum rules involving various meson-nucleon coupling constants. (auth)

37792 ENERGY BEHAVIOUR OF σ-PHASE SHIFT IN ππ SCATTERING. Serebryakov, V. V.; Shirkov, D. V. (Inst. of Mathematics and Computer Center, Novosibirsk, USSR). Phys. Lett., 25B: 138-9(Aug. 7, 1967).

A new type of formula is pointed out for describing the behavior of the phase shift in ππ scattering, which arises naturally in the theory of low energy scattering taking into account high energy contributions in the form of semiphenomenological short range repulsion. (L.B.S.)

37793 RELATIVISTIC DALITZ PLOT FOR THE SPIN-PARITY DETERMINATION OF THE L-MESON. Majerotto, W. (Institut fuer Hochenergiephysik, Vienna); Otter, G.; Moebius, P. Nucl. Phys., B2: 449-58(1967).

The relativistic matrix elements for possible spin-parity assignments of the L-meson decaying via special cascade decays are presented. The corresponding Dalitz plot distributions are compared with the nonrelativistic cases. (auth)

37794 ANTINUCLEAR FORCES. Phillips, R. J. N. (Atomic Energy Research Establishment, Harwell, Eng.). Rev. Mod. Phys., 39: 681-8(July 1967).

From American Physical Society, Nucleon-Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

Theoretical models of the nucleon–antinucleon interaction are surveyed in the few-hundred MeV region. Their relation to the nucleon–nucleon interaction, and any light they may shed on it, are discussed. (auth)

37795 REVIEW OF pi-pi PHASE SHIFTS. Walker, W. D. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Rev. Mod. Phys., 39: 695-9(July 1967). (COO-881-104).

From American Physical Society, Nucleon-Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

In the past several years several bits of evidence have been collected for the presence of a 0^+ isoscalar S-wave π–π resonance. The previous evidence is reviewed in the light of recent work. For low π–π masses the decay of the K^+ meson, $K^+ \to \pi^+ + \pi^- + e^+ + \nu$ gives useful information on the I = 0 phase shift. To gain information at higher mass values, a large collection of data from many experiments on the reactions involving pion production in π–p collision was made. Both the data on K decay and π–π collisions indicate a positive I = 0 phase shift at low energies followed by a gradual rise in the phase shift. Although one cannot rule out a resonant behavior near the ρ mass, it seems unlikely. The I = 2 phase shift seems to be negative, small (~20°) and slowly varying. The results seem to differ from predictions based on current algebra. (auth)

37796 GENERALIZED UNITARITY FOR PIONS. Wellner, Marcel (Syracuse Univ., N. Y.). Phys. Rev., 158: 1620-2 (June 25, 1967).

Generalized (or off-shell) unitarity is applied to the two-pion system below its inelastic threshold. The exact relativistic result reproduces the known result of potential-scattering theory for the partial-wave amplitude $\kappa e^{i\delta}(\kappa, \delta$ real) in any given isospin–angular-momentum channel: If one incoming pion is off the mass shell, then δ, as a function of the center-of-mass energy, is correctly given by its mass-shell value. (auth)

37797 HADRON DECAY PROCESSES AND THE QUARK MODEL. Van Royen, R. (CERN, Geneva); Weisskopf, V. F. Contract AT(30-1)-2098. Nuovo Cim. (10), 50A: 617-45(Aug. 1, 1967). (MIT-2098-290).

The quark model is used for the calculation of the decay rates of baryons and mesons. According to this model the 56 states of baryons contained in the fundamental octet and decuplet are S-states of a three-quark system and the 36 states of mesons in the scalar and vector octets are S-states of a quark-antiquark system. The states differ from each other in the relative orientation of spin and unitary spin of the quarks and not much in the spatial wave functions. The rates are calculated for transitions between these states which are: by weak interaction—emission of lepton pairs, by electromagnetic interaction—emission of γ-rays or electron pairs, and by strong interaction—emission of pions. These rates are calculated with the same method for all transitions. In all cases the interaction is transmitted by a spin-flip only (mechanical and/or isotopic). In addition, the same methods lend themselves to a calculation of the annihilation of the quark and the antiquark in mesons, accompanied by either a lepton pair emission (weak or electromagnetic interaction) or a pair of γ-rays. These methods allow the calculations of the rates of all decay processes where the number of hadrons remains unchanged, without any assumptions regarding the quark interactions. All that enter are the known weak, electromagnetic and strong coupling constants and the proton magnetic moment. The processes where a meson disappears depend also upon the value $|\psi(0)|^2$, which is the square of the wave function of the quark-antiquark system at zero distance. From comparison with the observed rates that magnitude turns out to be of the order fm^{-3} and proportional to the meson mass, predictions are made on the basis of the model for the partial width of decays not yet measured. (auth)

37798 UNITARY CORRECTIONS TO CURRENT-ALGEBRA CALCULATIONS ON THE π-π SCATTERING LENGTHS. Akiba, T.; Kang, K. (Brown Univ., Providence). Contract AT(30-1)-2262. Phys. Lett., 25B: 35-7(July 24, 1967). (NYO-2262TA-142).

In the current-algebra approach to s-wave ππ scattering lengths, the extrapolation of the amplitude from the consistency region of the off-mass-shell to the physical threshold is essential. The consequence of imposing unitarity to the Weinberg–Khuri amplitude through the use of sum rules for the scattering lengths is presented. It is pointed out that the small scattering lengths from current algebra may be attributed to the smallness of the Chew–Mandelstam parameter λ which, in turn, seems to be a natural consequence of the Adler's consistency condition that the amplitude should vanish at s = t = u = 1. (L.B.S.)

37799 APPLICATION OF THE STRONG-ABSORPTION MODEL TO ANTIPROTON NUCLEAR SCATTERING AT 3 GeV/c IN IONOGRAPHIC EMULSIONS. Kahn, R. (Faculte des Sciences, Caen, France). Nuovo Cim. (10), 50A: 665-7(Aug. 1, 1967).

A direct determination of the presence of Re A, the real part of the scattering amplitude, is made by means of the strong-absorption model, which also provides geometrical and dynamical information about the target nuclei. Spin effects are neglected. This model is applied to the elastic scattering of antiprotons of momentum 3 GeV/c by emulsion nuclei. (J.F.P.)

Strong (Baryon No. = 1)

Refer also to abstracts 37791, 38416, and 38417.

37800 (DESY-67/19) QUARK MODEL AND HIGH ENERGY PRODUCTION PROCESSES. Satz, H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). June 1967. 7p. Dep.

The additivity assumption for quark constituents in hadronic reactions is applied to high-energy production processes. It is shown that this assumption together with a statistical model for quark-quark production reactions leads to a simple picture which successfully describes the essential aspects of nonannihilation production reactions. (auth)

37801 (FTI-LA-1) COINCIDENCE OF REGGE TRAJECTORIES AND SU(2)^1_w SYMMETRY. Volkov, D. V. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1966. 4p. Dep.

A symmetry group for the nucleon-meson interaction is considered, which follows from (1) the analyticity of the nucleon-antinucleon scattering amplitudes at t = 0 (t is the total nucleon-antinucleon energy squared) and (2) the assumption that mesons belong to Regge trajectories and the trajectories intersect the j-axis (in the j-t plane) near the integer points. It is shown that relations satisfied by the helicity partial wave amplitudes are a consequence of the SU(2)^1_w group. (L.B.S.)

37802 (JINR-P2-3374) O VOSSTANOVLENII AMPLITUD MATRITSY RASSEYANIYA VPERED. (On the Reconstruction of the Forward Scattering Matrix Amplitude). Lapidus, L. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 12p. (In Russian). Dep.

The comparison with the dispersion relations, sum rules, etc. require the determination of the amplitudes of meson-nucleon, N−N and γ−N forward scattering. The formulas were obtained for this procedure at $\theta = 0^0$. The functions a(0) and b(0) contained in the amplitude of meson-nucleon scattering are determined by the measurements of the cross sections as well as the values of $P_0/\sin\theta$, R and A. In order to determine the amplitudes u(0), v(0), and h(0) contained in the N−N-scattering amplitude it is necessary to measure total cross sections and also to analyze particle polarization after scattering. The determination of the spin-orbital amplitude $c(\theta)/\sin\theta$ $\theta = 0^0$ is given. The amplitude of the nucleon Compton-effect is reduced at $\theta = 0^0$. An expression was obtained for the cross section of the polarized photon interaction with polarized nucleons. The determination of the imaginary parts of the amplitudes is made. The real parts are determined by measuring the differential cross sections. (auth)

37803 (JINR-P2-3383) DISPERSIONNYE PRAVILA SUMM I πN-RASSEYANIE PRI NIZKIKH I VYSOKIKH ENERGIYAKH. (Dispersion Sum Rules and High-Energy and Low-Energy πN-Scattering). Zhuravlev, V. I.; Meshcheryakov, V. A.; Rerikh, K. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 18p. (In Russian). Dep.

The dispersion sum rules for s- and p-wave lengths of πN-scattering as well as for high-energy scattering parameters are obtained. Comparison with experiment is made. (auth)

37804 (JINR-P2-3385) DISPERSIONNYE PRAVILA SUMM I ΠN-RASSEYANIE PRI VYSOKIKH ENERGIYAKH. (Dispersion Sum Rules and High-Energy ΠN-Scattering). Zhuravlev, V. I.; Meshcheryakov, V. A.; Rerikh, K. V.; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 8p. (In Russian). Dep.

The dispersion sum rules for the high-energy πN-scattering parameters are derived with the aid of the Cauchy theorem. Comparison with experiment is made. (auth)

37805 REGGE PARAMETERS FROM LOW-ENERGY SCATTERING. Olsson, M. G. (Univ. of Wisconsin, Madison). Phys. Rev. Lett., 19: 550-2(Aug. 28, 1967).

Two superconvergent sum rules are used to calculate the forward Regge rho-exchange parameters using only experimental data below the asymptotic region. The residue and intercept found in this manner are consistent with those determined by the asymptotic data. (auth)

37806 NONRESONANT PRODUCTION AMPLITUDES OR THE DECK EFFECT. Ross, Marc; Yam, Y. Y. (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett., 19: 546-50(Aug. 28, 1967).

The class of production processes which can be handled by single scattering methods are generalized to cases where more than two particles or resonances are produced. A prescription is given only for the background amplitude, that is, the amplitude which would be present in a certain channel if there were no resonances decaying into that channel. The approximation scheme for any 2 → n process is obtained by constructing all graphs with no loops and with three-point vertices only. (J.F.P.)

37807 PREDICTION OF REGGE PARAMETERS OF ρ POLES FROM LOW-ENERGY πN DATA. Dolen, R.; Horn, D.; Schmid, C. (California Inst. of Tech., Pasadena). Phys. Rev. Lett., 19: 402-7(Aug. 14, 1967). (CALT-68-133).

Using finite-energy sum rules important features of the Regge structure of ρ poles are predicted from low-energy πN data. The combined effect of N* resonances in generating (via the sum rules) properties of the exchanged ρ poles is discussed, thus starting a new type of bootstrap calculation. (auth)

37808 DECOMPOSITION OF LEGENDRE EXPANSION COEFFICIENTS FOR PSEUDOSCALAR MESON–SPIN-1/2 BARYON SCATTERING. Olson, Leonard E.; Trower, W. Peter (Univ. of Illinois, Urbana). J. Natur. Sci. Math., 6: 127-39(Oct. 1966).

A partial wave decomposition of the expansion coefficients for the Legendre polynomials used in meson (π)- and meson (K)-nucleon interactions is derived, and some results from these decompositions are tabulated. (J.F.P.)

37809 BARYONIC REGGE RECURRENCES AND U(6)$_w$ × O(2)$_w$ SYMMETRY WITH APPLICATIONS TO DECAYS AND PHOTOPRODUCTION. Freund, Peter G. O.; Maheshwari, Amar N.; Schonberg, Edmond (Univ. of Chicago). Phys. Rev., 159: 1232-5 (July 25, 1967). (COO-264-360; EFINS-66-116).

It is shown that if $N^+_\frac{5}{2}$*(1688) and $\Delta^+_\frac{5}{2}$*(1920) are the Regge recurrences of $N^+_\frac{1}{2}$(940) and $\Delta^+_\frac{3}{2}$(1238), respectively, they can be classified along with other particles in the (56, 1; L = 2) representation of the rest-symmetry group U(6) × U(6) × O(3). The couplings of these baryons are then fixed by the collinear U(6)$_w$ × O(2)$_w$ group. This leads to the following predictions: (R1) $(D/F)_{B^*_{\frac{3}{2}^+}\to B_{\frac{1}{2}^+}+\text{pseudoscalar meson}} = 3/2$; (R2) $\Gamma(\Delta^*(1920) \to N\pi)/\Gamma(N^*(1688) \to N\pi) = 1.84$; (R3-R4) the photoformation (i.e., the process γ + p → resonance → Nπ) of Δ*(1920) and N*(1688) should occur with the multipole ratios $(E_{3+}/M_{3+})_{\Delta^*(1920)} = 0$ and $(M_{3-}/E_{3-})_{N^*(1688)} \approx 0.1$, respectively. These predictions are shown to be in agreement with experiment. Generalizations to higher Regge recurrences are presented. (auth)

37810 SUM RULES FOR P-WAVE PION–NUCLEON SCATTERING LENGTHS FROM CURRENT ALGEBRAS. Raman, K. (Syracuse Univ., N. Y.). Phys. Rev., 159: 1501-10(July 25, 1967).

Using current commutation relations and the hypothesis of a partially conserved axial-vector current, approximate sum rules are derived relating pion-nucleon P-wave scattering lengths to the S-wave scattering lengths, the axial-vector renormalization constant g_A, the pion-nucleon coupling constant, the nucleon isovector magnetic moment, and the contribution of the low-energy N* resonances to the matrix element (between nucleon states) of the product of two axial-vector currents. The sum rules are compared with the available experimental data. (auth)

37811 DECIMET BARYONS AS "ELEMENTARY PARTICLES." Rajasekaran, G. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 159: 1488-92(July 25, 1967).

Models which regard the decimet B* as a composite of the octet baryons and octet pseudoscalar mesons usually give excessively large SU(3) violations for the B* because of the large mass differences within the baryon octet and meson octet. A model with B* as an elementary particle is constructed, and it is shown that in this model this difficulty can be resolved. (auth)

37812 HIGH-SPIN BARYONS. IV. DECAY MODES AND POSSIBLE REGULARITIES. Carruthers, P.; Shapiro, J. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 159: 1456-62(July 25, 1967).

Effective coupling constants for decays of the type baryon → baryon plus pseudoscalar meson are derived from experiment. In the absence of a reliable theory of the structure (barrier-penetration factor), an intrinsic meaning cannot be attributed to these couplings. However, for the pion-nucleon system we tentatively suggest the existence of several approximate rules. With appropriate definitions of the couplings, these are as follows: (1) The πBB coupling is independent of the baryon B; (2) decays down a trajectory have a strength independent of trajectory type and rung on the trajectory; (3) a scaling law holds for decays from one trajectory to another. An interesting result of this law, which is independent of the barrier factor, is that the decay $N_\frac{3}{2}$(1688) → Δ_1(1238)π is strongly inhibited relative to other p-wave decays. In the Appendix a simple derivation is given of the most general expression for the decay of an arbitrary-spin baryon into a spin-½ final baryon and a spin-zero meson. (auth)

37813 SELF-CONSISTENCY AND THE ROPER RESONANCE. Argyres, E. N.; Atkinson III, R. (Tufts Univ., Medford, Mass.). Phys. Rev., 159: 1446-7(July 25, 1967).

It is suggested that the Roper resonance R is primarily an N + (S-wave ππ pair) self-consistent bound state. Calculations are done with a simple model, coupled S_0 + N, π + N channels in the $J^P = \frac{1}{2}^+$, T = ½ state, where S_0 is a ππ S-wave state with mass 700 MeV. When the π + N channel is neglected, the R is self consistently generated by the R exchange force in the S_0 + N channel. When the π + N channel is included, the R bootstrap survives, and is stable against large variations in the cutoff associated with N* exchange. (auth)

37814 REGGE BEHAVIOR IN π⁻p CHARGE-EXCHANGE PROCESS AT THE REGION AROUND N(2190). Yokosawa, A. (Argonne National Lab., Ill.). Phys. Rev., 159: 1431-2(July 25, 1967).

An analysis based upon a Regge prediction indicates that the

measured differential cross sections for the π^-p charge-exchange process in the region of 2 GeV/c is consistent with the assignment of the $J = 1 - \frac{1}{2}$ state to N(2190) resonance, and that there does not seem to exist a sign change in the pole residue associated with the spin-nonflip amplitude in the Regge term in the interval of t from 0 to 0.8. The data and the Regge prediction were in close agreement. (auth)

37815 REGGE POLES AND HIGH-ENERGY SINGLE-PARTICLE PRODUCTION. Roberts, R. G. (Univ. of Durham, Eng.); Fraser, G. M. Phys. Rev., 159: 1297-1303(July 25, 1967).

A formalism is presented for the analysis of the high-energy production process $a + b \rightarrow 1 + 2 + 3$, where the participating particles may have any general spin. Its distinguishing feature is that no assumption is made of a quasi-two-particle intermediate state. The method consists of a consideration of the behavior in the crossed channel $a + \bar{} \rightarrow \bar{b} + 1 + 2$ when the amplitudes are dominated by a finite number of Regge Poles. The general problem of obtaining crossing relations for three-particle amplitudes is discussed, and finally examples are presented of the application of the formulas to the processes $\pi + N \rightarrow 2\pi + N$ and $pp \rightarrow pp\pi^0$. (auth)

37816 WEAK HADRONIC DECAYS IN THE QUARK MODEL. Breitenecker, M.; Morawitz, H.; Pietschmann, H. (Univ. of Vienna). Z. Phys., 204: 345-50(1967).

Various nonleptonic decay modes of baryons are calculated in a simple quark model. Form factors for various matrix elements are taken both from experiment and the quark model. Additionally the $K \rightarrow 2\pi$ and $K \rightarrow 3\pi$ decay modes are computed in the same model. The theory has the $\Delta I = \frac{1}{2}$ rule and static SU^6 built-in. A relation between the $\Sigma^+ \rightarrow N + \pi^+$ decay, not calculable in the model, and the $K \rightarrow 3\pi$ decay is given via an effective six quark interaction. Agreement with experiment is order of magnitude for the baryonic decays and worse for the K decays. (auth)

37817 SUM RULE FOR THE POMERANCHUK RESIDUUM. Gatto, R. (Univ., Florence. Istituto Nazionale di Fisica Nucleare, Florence). Phys. Lett., 25B: 140-1(Aug. 7, 1967).

A sum rule is derived for the residuum of the Pomeranchuk pole in the pion–nucleon B^+ amplitude. The sum rule has the form of a superconvergence relation involving the real part of the amplitude. (auth)

37818 DEDUCTION OF THE CHEW–LOW EQUATIONS AND THE ORIGIN OF THE CUT-OFF FUNCTION IN STATIC MODELS. Meshcheryakov, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 53: 175-82(July 1967). (In Russian).

A method for deduction of Chew–Low type equations from the Mandelstam representation is proposed. The meaning of the cut-off function in static models is elucidated; it is assumed that the cut from the process $(\pi + \bar{\pi}' \rightarrow \bar{N} + N')$ in the partial waves is taken into account in the function. It is shown that the function may also be regarded as not taking into account inelastic processes in the first two channels $\pi + N \rightarrow \pi' + N'$ and $\bar{\pi}' + N'$ and $\bar{\pi}' + N \rightarrow \bar{\pi} + N'$. (auth)

37819 INCLUSION OF LEPTONS IN THE QUARK SYSTEM. Akulov, N. S. (Physics Div., Academy of Sciences, Minsk). Dokl. Akad. Nauk BSSR, 10: 456-60(July 1966). (In Russian).

On assuming that nuclear kernels are actually existing fundamental particles ("reons") with integral charges (electrical and baryon), it is shown that all hadrons consist of an antireon to which either one or two reons are added. The electron maintains its individuality by not being split up, but it is able to migrate. The binding forces between reons in mesons and baryons are considered as a result of the decrease in mass of a graviton occurring on uniting a particle with an antiparticle, that is, during partial or complete neutralization of baryon charges b^+ and b^-. Since reons and antireons with $b^{\pm} \rightarrow 0$ are converted to leptons, they can be considered as constituent quasiparticles: $(+) = b^+e^+$; $(\bar{+}) = b^-e^-$; $(0) = b^+\bar{\nu}_e$; $(\bar{0}) = b^-\nu_e$. The mesons π^-, π^+ and π^0 are obtained by combining in pairs. The baryon dipole $b^+b^- = D$ is an important and general constituent part of the meson $\pi^+ = (+)\,(\bar{0})$ and of other mesons. The value of D mainly determines the mass, energy, and binding forces within mesons. It follows that "lepton mesons" of the following type are added to the dipole D in π-mesons: $W_0 = \nu_e\bar{\nu}_e$, $W^+ = \nu_e e^+$, $W^- = \bar{\nu}_e e^-$, and $W_0' = e^+e^-$. Thus, in the general case $\pi = DW$, that is, the addition of D converts "lepton mesons" W into ordinary π-mesons having a significantly greater mass than W. D actually decays by the channel: 1) $D \rightarrow \nu_\mu + \bar{\nu}_\mu$, and possibly by the channel: 2) $D \rightarrow \gamma$. It follows from 1) that the graviton D breaks up into muon neutrino and antineutrino. The W's should break down in leptons. These ideas are important in understanding the character of the lepton conversions of mesons such as π^0, π^+, μ^+ and μ^-. (TTT)

37820 SUPERCONVERGENCE IN πN^* ELASTIC SCATTERING. Frampton, P. H. (Dept. of Theoretical Physics, Oxford). Nucl. Phys., B2: 518-24(1967).

Eight forward (t = 0) superconvergence sum rules are studied in πN^* elastic scattering. A preliminary comparison with experiment using known low-lying states is encouraging. There is evidence of cancellation in sum rules where a Regge branch point may make the integral nonconvergent. (auth)

37821 MESON–BARYON COUPLINGS IN A QUARK MODEL. Mitra, A. N. (Univ. of Delhi); Ross, Marc. Phys. Rev., 158: 1630-8(June 25, 1967).

The widths for decay of low-lying baryons of negative parity into baryon plus pseudoscalar meson are determined in a quark model and extensively compared with experiment. One conclusion is that Ξ^* (1816) is not in an octet with N^* (1518), Y_1^* (1660). A second prediction is a kinematical factor in s-wave decay enhancing the decay into high-mass mesons (K and η over η), which provides a qualitative reason for η peaks at threshold. Properties of the many missing baryon resonances are discussed. Channels appropriate for the search for some of these are indicated. (auth)

37822 AMBIGUITIES IN THE PHENOMENOLOGICAL DETERMINATION OF REGGE-POLE PARAMETERS. Arbab, Farzam; Bali, Naren F.; Dash, Jan W. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 158: 1515-21 (June 25, 1967). (UCRL-17325).

An attempt is made to eliminate some of the ambiguities of the phenomenological determination of Regge-pole parameters. To this end, charge-exchange reactions involving the ρ and R trajectories are studied. It is found that these ambiguities can not be resolved with the available data. (auth)

37823 MASS PERTURBATIONS IN A BETHE–SALPETER-EQUATION MODEL OF THE NUCLEON. Harte, John (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 158: 1521-9(June 25, 1967). (UCRL-17329).

A model of the nucleon based on the Bethe–Salpeter equation is used to investigate the response of the binding energy to small perturbations. Comparisons with the predictions of an N/D model are drawn, and it is shown that the effect of perturbations in the strong-interaction coupling constant may be better described with off-shell dynamics. In this model neither the photon-exchange graph nor the feedback effect can explain the neutron–proton mass difference, but if N^* exchange provides the attractive force to bind the nucleon, then radiative corrections to the $N^*N\pi$ vertex may explain the sign of $m_n - m_p$. Evidence is given for the predominance in this model of pseudovector rather than pseudoscalar πNN coupling. (auth)

37824 CURRENT-ALGEBRA DETERMINATION OF LOW-ENERGY PION–NUCLEON SCATTERING. Schnitzer, Howard J. (Brandeis Univ., Waltham, Mass.). Phys. Rev., 158: 1471-9 (June 25, 1967).

The P-wave pion-nucleon scattering lengths and S-wave effective ranges are studied by means of the current-commutator algebra and the hypothesis of partially conserved axial-vector current (PCAC). This requires a model for the weak axial-vector production; but it is shown that the production of baryon resonances with $J = \frac{3}{2}^-$ and $J > \frac{3}{2}$ do not contribute to these threshold quantities, so that only the nucleon and N^* contributions are included in the model for the weak amplitude. The predicted P-wave scattering lengths are in reasonable agreement with experiment, while a discrepancy for the isotopic even effective range implies a possible T = 0 exchange in the weak amplitude. The other S-wave effective range gives a determination of the induced pseudoscalar coupling which is a factor 2 smaller than the PCAC value. (auth)

37825 MODEL OF THE N*(1236). Shaw, Graham (Rutherford High Energy Lab., Chilton, Eng.). Phys. Rev., 158: 1479-84 (June 25, 1967).

A variational method is proposed, and is used to calculate the width and the radiative widths of the N*(1236). Good agreement with experiment is obtained. (auth)

37826 ODD-PARITY BARYON RESONANCES. Capps, Richard H. (Northwestern Univ., Evanston, Ill.). Phys. Rev., 158: 1433-43(June 25, 1967).

A formalism is developed that is useful for discussing the spin dependence of collinear reaction amplitudes of hadrons. The formalism is applied to the potentials in meson-baryon states, where the mesons and baryons are members of the $SU(6)_W$ supermultiplets 35 and 56. The simultaneous assumptions of $SU(6)_W$ symmetry and dominant low partial waves lead to predictions concerning odd-parity baryon resonances very similar to those of the quark model. If the potential corresponds to the $SU(6)_W$ representation 70, the set of predicted resonances corresponds to

the (70,3) representation of SU(6) ⊗ O(3). Effects are present that are analogous to spin-orbit splitting and configuration mixing in the quark model. These effects are calculable, so that the model leads to more predictions than the quark model. The predictions concerning the quantum numbers, masses, and branching ratios of the resonances are compared with experiment. The over-all agreement is good. (auth)

37827 EFFECT OF THE QUASIPOLE ON THE π-N FORWARD SCATTERING AMPLITUDES. Sawada, Tetsuo (Tokyo Univ. of Education). Phys. Rev., 158: 1421-4(June 25, 1967).

It is shown that a quasipole plays an important role in low-energy meson-baryon scattering. The influence of this quasipole, which exists on the second Riemann sheet just below the elastic threshold and has a residue of the same order of magnitude as that of the nucleon pole, is analyzed by extrapolation of the data of the pion-nucleon scattering amplitude. Since the residue of the quasipole is related to the pion-nucleon coupling constant, this extrapolation gives an independent possibility for determining the coupling constant. The result is $g^2/4\pi = 13.9$. (auth)

37828 PARTIAL-WAVE ANALYSIS OF $K^-p \rightarrow \Xi^-K^+$ AT 2 GeV/c. Trippe, Thomas G.; Schlein, Peter E. (Univ. of California, Los Angeles). Phys. Rev., 158: 1334-7(June 25, 1967).

A partial-wave analysis was performed on $K^-p \rightarrow \Xi^-K^+$ at 2 GeV/c. The Legendre-polynomial expansions of $d\sigma/d\Omega$ (coefficients A_l) and of $Pd\sigma/d\Omega$ (coefficients B_l) have significant contributions for A_1, A_2, A_3, B_1, B_2, and one isolated higher-order moment, A_6 (a 3.5σ effect). Using the measured values of A_l and B_l ($l = 1, 2, 3$), the partial-wave equations were solved (using a search technique) for the amplitudes $S_{\frac{1}{2}}(= P_{\frac{1}{2}}^*)$, $P_{\frac{1}{2}}(= S_{\frac{1}{2}}^*)$, $P_{\frac{3}{2}}(= D_{\frac{3}{2}})^*$, and $D_{\frac{3}{2}}(= P_{\frac{3}{2}}^*)$, where the bracketed partial waves indicate the Minami-transform-complex-conjugation ambiguity, unavoidable in an analysis at a single energy. The isolated A_6 term may be understood as due to a small $J \geq 9/2$ amplitude interfering with one of the $J = 3/2$ amplitudes. The measured cross sections for Ξ^-K^+, Ξ^0K^0, and Ξ^-K^0 production are consistent with baryon-exchange dominance with a ($T = 0/T = 1$) isotopic-spin ratio of (7.0 ± 2.3) for the exchanged baryon. (auth)

37829 AN EXTENSION OF THE π-N AND π-Λ DISPERSION RELATIONS. Bessis, J. D.; Glaser, V. (CERN, Geneva). Nuovo Cim. (10), 50A: 568-82(Aug. 1, 1967).

It is shown, starting from the usual assumptions of "axiomatic field theory," that for the π-N and π-Λ elastic-scattering processes the dispersion relations hold for complex values of t inside the circle of radius $|t| = 4\mu^2$, where μ is the pion mass. (auth)

37830 FORWARD DISPERSION RELATIONS AND LOW-ENERGY KN SCATTERING. Rood, H. P. C. (CERN, Geneva). Nuovo Cim. (10), 50A: 493-503(Aug. 1, 1967).

KN dispersion relations, evaluated with the correct Y_0^* effective-range formula, give $g^2_{\Lambda KN} \approx 7.4$ as against the value 4.8 of Lusignoli et al. Some $T = 0$, P-wave is also needed. (auth)

37831 CUTKOSKY–LEON BOOTSTRAP MODEL AND THE STRONG-COUPLING MODEL. Chen, Fei S. (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 158: 1529-33(June 25, 1967).

The static π-N bootstrap model based on the Bethe–Salpeter equation is applied to the study of the mass spectrum and the meson coupling constants when isobars heavier than $N_{3,3}^*$ are included. By assuming $I = J$, the solutions for two models were obtained which are constructed by adding, up to $I = J = 7/2$, the isobars $N_{21,2\,J}^*$ to those of the familiar model of the N-$N_{3,3}^*$. It was discovered that this Bethe–Salpeter bootstrap model (or Cutkosky–Leon model) contains a solution which is identical to that from the strong-coupling model for the case of charge-symmetric pseudoscalar-meson theory; in this solution there are an infinite number of degenerate isobars with their isospin equal to their spin. Also included in the table of results is the SU(4) prediction for the various coupling constants when heavier isobars are included. The SU(4) model contains in addition to the pions the ρ and η mesons. It is noticed that the results of bootstrapping and SU(4) are similar and that the deviations between them are less than 50%. It is also noticed that the heavier isobars act in the bootstrap model like a small perturbation on the low-lying isobar states. (auth)

37832 BARYON EXCHANGE IN Ξ PRODUCTION PROCESSES. James, Philip B. (Univ. of Illinois, Urbana). Phys. Rev., 158: 1617-19(June 25, 1967).

Baryon exchange is studied in relation to the production of $\bar{\Xi}^-$ and Ξ^0 hyperons in K^-p interactions. Amplitudes for these reactions are derived from the exchanges of Λ, Σ, $Y_1^*(1285)$, and $Y_0^*(1405)$ baryons, with couplings determined from experimental data and SU_3; absorptive corrections and vertex form factors are allowed as possible modifications of these amplitudes. The effects of interference between these exchanges simultaneously account for the observed partial-wave structure in Ξ^- production and the suppression of Ξ^0 production relative to $\bar{\Xi}^-$ production at intermediate energies; no enhancement of the $Y_0^*(1405)$ contribution, previously invoked to reconcile these two features, is necessary. The implications of the model for Ξ^0 production are discussed. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 37802 and 37815.

37833 (JINR–P2-3358) IMPUL'SNYE I UGLOVYE SPEKTRY CHASTITS, ROZHDENNYKH V VYSOKOENERGETICHESKIKH pp-STOLKNOVENIYAKH. (Momentum and Angular Spectra of Particles Produced in High-Energy p-p Collisions). Zinov'ev, G. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 22p. (In Russian). Dep.

The momentum and angular distributions of secondary particles in inelastic p-p interaction at T = 40, 60, and 80 GeV are obtained within the statistical model of multiple particle production and are compared with the experimental data and with empirical dependencies which exist in the literature. (auth)

37834 PROTON–DEUTERON SCATTERING AT 1 BeV. Bennett, G. W. (Brookhaven National Lab., Upton, N. Y.); Friedes, J. L.; Palevsky, H.; Sutter, R. J.; Igo, G. J.; Simpson, W. D.; Phillips, G. C.; Stearns, R. L.; Corley, D. M. Phys. Rev. Lett., 19: 387-90(Aug. 14, 1967).

Cross sections for elastic and inelastic scattering of protons on deuterons were measured at 1 GeV for center-of-mass angles between 10 and 170°. The elastic forward-scattering results are used to test the multiple-scattering theory of Glauber. (L.B.S.)

37835 PHASE-SHIFT CALCULATIONS FOR REAL AND REALISTIC POTENTIALS. Ali, Shamsher; Islam, Mozaharul (Atomic Energy Centre, Dacca, Pakistan). J. Natur. Sci. Math., 6: 169-75(Oct. 1966).

A numerical method of calculation of phase shifts was outlined. This method can also be used to calculate the low-energy effective range parameters, namely the scattering length and the effective range. The zero energy parameters calculated for various potentials with this method were compared with the ones calculated for the same potentials but by other independnet methods and were found to be quite satisfactory. The accuracy of the method was also verified. (auth)

37836 NEUTRAL PION PRODUCTION IN P–P INTERACTIONS AT 2.8 BeV/c. Schmidt, D. L.; Ijaz, M. A. (Virginia Polytechnic Inst., Blacksburg). J. Natur. Sci. Math., 6: 141-53(Oct. 1966).

An analysis of the data on the interaction $p + p \rightarrow p + p + \pi^0$ is presented. Approximately 45,000 pictures were taken of the 2.8 GeV/c proton interactions in a hydrogen bubble chamber. The cross section for π^0 production was found to be 3.89 ± 0.20 mb. The angular distributions indicate the presence of interfering amplitudes besides the $T = J = 3/2$ state. (J.F.P.)

37837 $^3H_\Lambda$ AND LAMBDA–d SCATTERING. Kashef, B. Ghaffary; Schick, L. H. (Univ. of Southern California, Los Angeles). Nuovo Cim. (10), 50B: 395-7(Aug. 11, 1967).

The Faddeev equations with S-wave separable potentials are used to calculate the binding energy of the Λ in the hypertriton as well as some low-energy Λ–d cross sections. The same value of the Λ binding energy was obtained with and without a repulsive core in the N + N potential, and this value was found to be in agreement with experiment. (J.F.P.)

37838 A NOTE ON THE ΛΛ-HYPERNUCLEUS $^{14}C_{\Lambda\Lambda}$. Ali, S.; Kok, L. P.; Grypeos, M. E. (International Atomic Energy Agency, Trieste, Italy). Nuovo Cim. (10), 50B: 373-7(Aug. 11, 1967).

The results of an investigation of the yet unobserved system ΛΛ-^{14}C, using the Λ–Λ potential strengths determined from ΛΛ-^{6}He, are presented. In view of the fair rigidity of the ^{12}C core, ΛΛ-^{14}C is approximated by a three-body ΛΛ-^{12}C model. The results presented were obtained using the equivalent two-body method for three-body systems. (J.F.P.)

37839 ULTRAHIGH-ENERGY INTERACTION AS PARTICLE PHYSICS. Koshiba, M.; Nozaki, T.; Totsuka, Y.; Yamada, S. (Tokyo Univ.). J. Phys. Soc. Jap., 22: 1321-36(June 1967).

Copious production of ϕ meson is observed in nuclear interactions of energies from 10^{12} eV to 10^{13} eV. It is further shown that a new type of baryon $\varkappa$ is very likely to explain the various features of ultrahigh-energy interactions so far observed. (auth)

37840 Σ^+-p INTERACTIONS AND SU(3) SYMMETRY. De Souza, P. D. (Indiana Univ., Bloomington). Phys. Rev., 159: 1492-5(July 25, 1967).

A potential-model calculation is made of the singlet scattering length and effective range for Σ^+-p scattering. The potential is derived from an SU(3)-invariant Lagrangian in which the 0^- meson octet and a 0^+ meson singlet are coupled to the baryons, and the effect of other mesons is replaced by a hard core. The effect of symmetry breaking is taken into account by allowing all particles to have their physical mass values. This calculation is carried out for several values of the F/D ratio in the vicinity of $\frac{2}{3}$ and the results are compared with the SU(3) prediction $\sigma^0(n,n) = \sigma^0(\Sigma^+,\Sigma^+)$. (auth)

37841 DETERMINATION OF THE NUCLEON–NUCLEON ELASTIC SCATTERING MATRIX. VI. NEW RESULTS NEAR 50 MeV. Wright, Robert M.; MacGregor, Malcolm H.; Arndt, Richard A. (Univ. of California, Livermore). Phys. Rev., 159: 1422-6(July 25, 1967). (UCRL-70075(Rev.)).

A previous phase-shift analysis at 50 MeV has been improved by increasing the completeness of the data set. Since no new data have become available at this energy, it was necessary to expand the range of energies. Reasonable values are for the ϵ_1 phase shift and for the pion-nucleon coupling constant g^2. Certain ways of handling the data result in an ambiguity in the T = 0 phase shifts, which were explored in detail. It is concluded that no precise, reliable values for the T = 0 phases can as yet be derived from existing data near 50 MeV, although the present solutions must be in the neighborhood of the correct solution. (auth)

37842 CONFIGURATION-SPACE APPROACH TO THREE-PARTICLE SCATTERING. Zickendraht, W. (Univ., Marburg, Ger.). Phys. Rev., 159: 1448-55(July 25, 1967).

A configuration-space approach to the three-particle problem which has been proposed for bound states in previous publications is generalized to include scattering states. It is illustrated for the case of nucleon-deuteron scattering. The coupling between the elastic and the inelastic channel can be treated in an elegant way. The problem is reduced approximately to a finite system of coupled differential equations, in which the unknown functions depend on a single variable only. An iteration procedure for the solution is proposed. The accuracy of the method is tested for a simple example. (auth)

37843 CONTRIBUTIONS OF REGGE CUTS TO FORWARD NUCLEON–NUCLEON SCATTERING. Branson, D.; Nussinov, S.; Treiman, S. B.; Weisberger, W. I. (Palmer Physical Lab., Princeton, N. J.). Phys. Lett., 25B: 141-3(Aug. 7, 1967).

Empirical consequences of possible contributions to the asymptotic behavior of forward nucleon–nucleon scattering from cuts in the angular momentum plane are discussed. The model used for investigating the presence of cuts is the iteration of the scattering amplitude via elastic unitarity in the s-channel. (L.B.S.)

37844 MODEL-INDEPENDENT CONTRIBUTION IN PROTON–PROTON BREMSSTRAHLUNG. Nyman, E. M. (Stanford Univ., Calif.). Phys. Lett., 25B: 135-8(Aug. 7, 1967).

Part of the invariant amplitude for p-p bremsstrahlung can be shown to be independent of the off-shell behavior of the p-p interaction. The corresponding cross section agrees with the measured values. The model-independent terms are computed in a fully covariant and gauge-independent fashion, employing the best available representation of the elastic p-p scattering amplitude. (auth)

37845 THE N–N INTERACTION, 1967: AN OVERVIEW AND CONFERENCE SUMMARY. Green, Alex E. S. (Univ. of Florida, Gainesville); MacGregor, Malcolm H.; Wilson, Richard. Rev. Mod. Phys., 39: 498-508(July 1967).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

A summary is given of our state of knowledge of the nucleon–nucleon interaction as derived from the invited and contributed papers and the informal discussions. It appears that much progress has been made since 1960 and that despite the use of widely divergent formalisms current theoretical models have much of the same physical substance. The informal discussions of the conference, particularly those related to the experimental, phenomenological, and theoretical aspects of the nucleon–nucleon interaction in the elastic scattering region are summarized. (auth)

37846 DETERMINATION OF THE p-p ELASTIC SCATTERING MATRIX. MacGregor, Malcolm H. (Univ. of California, Livermore). Rev. Mod. Phys., 39: 556-9(July 1967). (UCRL-70403; CONF-670302-5).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

A phase-shift analysis of p-p scattering data from 10 to 400 MeV is presented. Phase-shift energy-dependent forms having a plausible analytic structure are used, and matrix techniques are employed for the search procedure. An interaction process was used to arrive at a self-consistent p-p data set. This analysis is being extended to higher energies and to the n-p system. (auth)

37847 PHENOMENOLOGICAL PHASE-PARAMETER FITS TO N–N DATA AT INTERMEDIATE ENERGIES. Breit, G. (Yale Univ., New Haven). Contract AT(30-1)-1807. Rev. Mod. Phys., 39: 560-70(July 1967). (YALE-1807-42).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

New p–p and n–p phase-parameter multiple energy fits (Y–IV) intended for the energy range from ~8 MeV to ~340 MeV employing 947 measurements for p–p and 1023 for n–p are discussed. Improvements over older work include: more careful joining to low-energy data involving phase searches beginning at 1.397 MeV for p–p and 3.205 MeV for n–p; inclusion of triple scattering and polarization data at 430 MeV; data lumping in smaller groups than previously; increased accuracy of one-pion-exchange (OPE) phases; graded introduction of OPE treatment. Related matters include: effects of Coulomb field corrections and of corrections for the apparent violation of short-range charge independence for the new fits and the older YRB1(K_0)–YLAN4M; effects of varying the difference between the p–p and n–p effective ranges within its uncertainty limits; analyses of mockups of experiments designed to improve knowledge of the difference just mentioned; comparisons of values of the pion–nucleon coupling constant g_{00}^2 derived from p–p and n–p data in relation to the long-range charge independence of N–N interactions. (auth)

37848 PHASE-SHIFT ANALYSIS OF DATA ON NUCLEON–NUCLEON SCATTERING AT LOW ENERGIES. Kazarinov, Yu. M.; Lehar, F.; Yanout, Z. (Joint Inst. for Nuclear Research, Dubna, USSR). Rev. Mod. Phys., 39: 571-3(July 1967).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

The use of a polarized proton target (PPT) in experiments below 30 MeV opens new possibilities for investigating deviations from pure S scattering, occurring at these energies. It seems highly probable, that a detailed investigation of P- and D-state nucleon interactions at 10–20 MeV, will make it possible to extend the region, in which the scattering amplitude is determined unambiguously to energies, at which the nucleons interact practically only in the S state, so that the phase-shift analysis is considerably simpler. It is therefore important to perform a phase-shift analysis of the existing experimental data in order to obtain information necessary for the planning of future experiments. This was done at 9.7, 14.5, and 18.2 MeV. (auth)

37849 NEUTRON–NEUTRON INTERACTION. Slaus, Ivo (Ruder Boskovic Inst., Zagreb). Rev. Mod. Phys., 39: 575-83 (July 1967).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

The present status of the problem of charge dependence is discussed. The information about the neutron–neutron interaction derived from the two-neutron system, three-nucleon systems, final-state interactions in multiparticle reactions, and peripheral processes is critically evaluated. The experimental data indicate the breakdown of charge independence by about 3–5%. Evidence concerning the violation of charge symmetry is inconclusive, but it seems that most of the data are consistent with the assumption that charge symmetry is satisfied within 0.5–1%. The most suitable studies which might improve the knowledge of the neutron–neutron forces are indicated. (auth)

37850 INTERACTION OF TWO NUCLEONS AT LOW ENERGIES. I = 1. Heller, Leon (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Rev. Mod. Phys., 39: 584-90(July 1967). (LA-DC-8606).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

A summary of the knowledge of the low-energy interaction of two nucleons with one unit of isobaric spin is presented. The single-energy analyses of accurate low-energy proton–proton scattering data are discussed with emphasis upon the electromagnetic effects which were included and those which should be. The phase shifts which result are presented and discussed in terms of the effective range expansion and potentials. A brief discussion of charge symmetry and independence in terms of potentials and dispersion relations is given. The equality of the neutron–neutron and proton–proton nuclear interactions, which seems to be established, may not be sufficient for understanding the problem of mirror nuclei. The question of charge independence is much more difficult. (auth)

37851 PION INSTABILITY IN NUCLEON–NUCLEON SCATTERING. Lassila, K. E. (Iowa State Univ. of Science and Technology, Ames. Research Inst. for Theoretical Physics, Helsinki); Peltola, E. I. Rev. Mod. Phys., 39: 591-2(July 1967).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

Pion instability effects are inserted into the OPEP part of the Hamada–Johnston and Yale potentials to determine if any observables are affected by these corrections. A contribution of 0.030 F to the observed neutron–neutron and singlet state neutron–proton scattering length difference is found. (auth)

37852 MESON THEORETIC N–N INTERACTIONS FOR NUCLEAR PHYSICS. Green, A. E. S.; Sawada, T. (Univ. of Florida, Gainesville). Rev. Mod. Phys., 39: 594-610(July 1967).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

One-boson-exchange interactions are derived for pseudoscalar (P), vector (V), scalar (S), axial vector (A), and antisymmetric tensor (T) mesons. The Schrödinger–Pauli–Breit limit is obtained for a combination of such Diracian OBE interactions. The phase shifts are calculated for the purely relativistic $\pi-5\omega$ model and it is found possible to fit the S-wave phase shifts by adjusting one coupling constant and one regularization parameter. Then by breaking this model slightly several accurate representations of the N–N interaction are developed for all waves with a moderate number of adjustable parameters, several of which are fixed by external considerations. A physical interpretation of the results particularly the velocity-dependent interactions is presented. Finally the results are discussed in relation to other PVS models. (auth)

37853 NUCLEON–NUCLEON INTERACTION CONSISTENT WITH THEORY AND EXPERIMENT. Lomon, E.; Feshbach, H. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Rev. Mod. Phys., 39: 611-21(July 1967). (MIT–2098-308).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

The nucleon–nucleon data are fitted by a boundary condition model interaction determined largely by theoretical forms. One- and two-pion, ρ, ω, and η meson exchange adiabatic local potentials determine the interaction outside $r_0 \approx \frac{1}{2}\mu^{-1}$. Only the two-pion-exchange contribution contains a degree of ambiguity measured by the parameters ξ and λ for the pion ladder and nucleon pair diagrams, respectively. The interaction is determined at r_0 by an energy-independent boundary condition for those partial waves sensitive to the short-range interaction. A very good fit to the p–p data and a good fit to the n–p data below 350-MeV nucleon laboratory energy, are obtained, comparable to the best phenomenological fits. The optimum or fixed values of exchange particle masses and coupling constants corresponds to their known physical values, and the λ and ξ parameters optimize in their theoretical range. The value attained by r_0 corresponds to that predicted by the theory of the boundary condition model. There remain 19 boundary condition parameters, freely fitted, to which the data are sensitive. These may in principle be related to pion–nucleon amplitudes. Rescattering and ϕ meson exchange contributions to the potential remain to be investigated, as does the effect of coupling to inelastic channels. (auth)

37854 MESON THEORY OF NUCLEON–NUCLEON INTERACTION. Wong, David Y. (Univ. of California, San Diego, La Jolla). Rev. Mod. Phys., 39: 622-8(July 1967).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

Exchange of π, η, ρ, ω, ϕ mesons and a pair of pions in the relative s state can account for all the important features of the nucleon–nucleon interaction. The method of dispersion relation is employed to calculate nucleon–nucleon phase shifts starting from the relativistic single-particle-exchange Feynman diagrams. Validity of the method is tested in the nonrelativistic limit where the solution of the dispersion relation is compared to the solution of the Schrödinger equation for a superposition of Yukawa potentials. For potentials that contain a long-range attraction and a strong short-range repulsion there is little difference between the two solutions. In the meson model, the attraction comes primarily from the π and the s-wave two-pion exchange. The exchange of ω and ϕ produces the required short-range repulsive force. Two approaches to the nucleon–nucleon scattering problem were considered. The meson model was taken to be the basis of a detailed fit to the scattering data. A total of 12 adjustable parameters were introduced and a fit to the pp and np data was obtained. The accuracy is comparable to that of pure phenomenological potentials with considerably more parameters. The number of parameters in the meson model is minimized using approximate symmetry considerations to clarify the physical significance of the model. With only four adjustable parameters, all the important features of the phase shift are reproduced. These results lend support to the idea that the strongly correlated multimeson systems ρ, ω, and ϕ play a dominant role in the inner part ($\lesssim$0.3 F) of the nucleon–nucleon potential while the exchange of two pions in a relative s-state accounts for the gross feature of the medium-range attraction. (auth)

37855 NUCLEON–NUCLEON INTERACTION AT SMALL DISTANCES. Tamagaki, Ryozo (Hokkaido Univ., Sapporo). Rev. Mod. Phys., 39: 629-34(July 1967).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

In 1956, the one-pion-exchange potential (OPEP) at large internucleon distances was established and this first success in substantial understanding of nuclear forces has become the keystone in studying nuclear forces since then. As was reported previously this success was obtained following the Taketani theory, which proposes to approach nuclear forces from the outside of the nucleon by combining meson-theoretical predictions at large distances with phenomenological descriptions at small distances. It is intended to report basic thoughts of approaches and main results recently obtained concerning nuclear forces at small distances. (auth)

37856 NUCLEON–NUCLEON SCATTERING, PION–NUCLEON SCATTERING, AND THE NUCLEON FORM FACTORS. Signell, Peter; Durso, John (Michigan State Univ., East Lansing). Rev. Mod. Phys., 39: 635-9(July 1967).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

The one-pion and two-pion-exchange contributions to pion–nucleon scattering, nucleon–electron scattering (nucleon electromagnetic form factors), and nucleon–nucleon scattering are examined using as closely similar methods as possible. These contributions are compared to experimental phase shifts which do not depend on the exchange of more than two pions. (auth)

37857 MESON–NUCLEON COUPLING CONSTANTS FROM LOW-ENERGY PROTON–PROTON SCATTERING. Koepp, G. (Technische Hochschule, Aachen). Rev. Mod. Phys., 39: 640-7 (July 1967).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

Coupling constants of various scalar and vector mesons to the nucleon are determined from empirical proton–proton partial wave amplitudes of high angular momenta. Various fits are described and compared with predictions of unitary symmetry schemes. (auth)

37858 PION-PRODUCTION AMPLITUDES AND NUCLEON–NUCLEON INTERACTION. Amaldi, U. Jr. (Istituto Superiore di Sanita, Rome). Rev. Mod. Phys., 39: 649-56(July 1967).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

The present knowledge of the partial-wave proton–proton absorptions due to pion production below 1.5 GeV of laboratory kinetic energy is summarized. The three models which were used for obtaining this kind of information from inelastic data are discussed: the Mandelstam model, the one-pion-exchange model, and the K matrix, or damping, model. Although there is some disagreement, in the near future one can hope to obtain reasonably trustworthy values for partial wave absorptions as a function of energy from the threshold of pion production to about 1.5 GeV. This information will be useful not only to reduce the number of parameters in high-energy phase-shift analysis, but also to be introduced as known inelasticities in partial wave dispersion relations. (auth)

37859 NUCLEAR STRUCTURE AND THE NUCLEON–NUCLEON INTERACTION. Moszkowski, Steven A. (Univ. of California, Los Angeles). Rev. Mod. Phys., 39: 657-62(July 1967).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

The results of some nuclear structure calculations using realistic two-body interactions which fit nucleon–nucleon scattering data are very briefly summarized. Using realistic interactions, and many-body techniques such as the reference spectrum and an approximate treatment of three-body correlations the binding energy and density of nuclear matter are quantitatively accounted for. Realistic interactions were also used in Hartree–Fock calculations and results for the ground state of ^{16}O are briefly discussed. Finally there are some remarks concerning the effective interaction to be used in shell-model calculations and in particular, the need to include core excitation in order to fit quantitatively the spectrum of two-particle nuclei such as ^{18}O. (auth)

37860 NUCLEON–NUCLEON INTERACTION AT HIGH ENERGIES. Leader, E. (Cambridge Univ., Eng.). Rev. Mod. Phys., 39: 663-9(July 1967).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

The present situation in the understanding of high-energy physics is reviewed. In high-energy physics there is a plethora of theories, which often look quite incompatible, but which share one grand claim. For each of them it has been possible to find at least one set of experimental data with which they agree. The outstanding experimental features which are discernible in the nucleon–nucleon system at energies above about 3-GeV/c laboratory momentum are summarized. Some of the main theoretical ideas are considered, and it is examined to what extent they are compatible with the experimental properties described. (auth)

37861 PHENOMENOLOGICAL ANALYSIS OF PROTON–PROTON SCATTERING IN THE INELASTIC REGION. Hoshizaki, Norio (Kyoto Univ.). Rev. Mod. Phys., 39: 700-5(July 1967).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

A survey of recent works concerning the phase-shift analysis of p-p scattering in the energy region from 400 MeV to a few GeV is presented. The method of analysis and results are described. Physical implications of them are also discussed. A new scheme of analysis is proposed. It modifies the previous method in fixing the imaginary phase shifts to the values from the one-pion model with unitarity. Reanalysis of the p-p data at 970 MeV shows the validity of the new scheme. (auth)

37862 PHASE-SHIFT ANALYSIS OF DATA AND THE DETERMINATION OF THE SCATTERING AMPLITUDE IN THE NUCLEON ENERGY REGION ABOVE PION-PRODUCTION THRESHOLD. Kazarinov, Yu. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Rev. Mod. Phys., 39: 706-9(July 1967).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

Historically it has become a habit that the phase-shift analysis is carried out by the experimenters. Thus, each experimental investigation is completed by improving the earlier results of the phase-shift analysis and thus, the phase-shift analysis may be considered as an original method for the treatment of experimental data. The phase-shift analysis turns out to be a means first, to test how well new experimental results agree with the whole collection of earlier known data and, second, to more accurately plan further experiments. In these conditions a phase-shift analysis program is used at one energy. The program implies the following assumptions: There is a charge independence of nuclear forces. Nucleon interaction in states with high orbital momenta is correctly described with a one-pion Feynman diagram. Orbital momenta, beginning from those for which a one-pion approximation can be justified, are determined keeping in mind that in the one-pion approximation, polarization in nucleon–nucleon scattering is equal to 0. Pions are produced, mainly, from initial states with total isotopic spin 1. Results of the analyses will be given. (auth)

37863 PHASE-SHIFT REPRESENTATION FOR NUCLEON–NUCLEON SCATTERING ABOVE PION-PRODUCTION THRESHOLD. Arndt, Richard A. (Univ. of California, Livermore). Rev. Mod. Phys., 39: 710-15(July 1967). (UCRL-70542).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

A number of questions relating to phase-shift representations of nucleon–nucleon scattering in an energy range where inelastic channels are open and may contribute significantly to such representations are discussed. While attention will be directed specifically toward nucleon–nucleon scattering above 400 MeV, the relevance is seen of such questions being applied to similar strongly interacting systems. (auth)

37864 RELATIVISTIC TREATMENT OF MUON CAPTURE IN DEUTERIUM. APPLICATION TO THE DETERMINATION OF NEUTRON–NEUTRON SCATTERING LENGTH AND EFFECTIVE RANGE. Cremmer, E. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys., B2: 409-23(1967).

A relativistic calculation of muon capture in deuterium is given. The important effect of hyperfine structure is treated relativistically. A determination of neutron–neutron scattering length and effective range is made. Vertex functions are used to describe the proton-neutron-deuteron vertex and the Omnes method to compute the final-state interaction. It is shown that an accuracy of 2.5% in spectrum and capture rate must allow a determination of r_{os} and a_s with an accuracy of, respectively, ±0.2 fm and ±0.7 fm. (auth)

37865 MESON MIXING AND THE CHARGE ASYMMETRY OF THE N–N INTERACTION. Downs, B. W. (Univ. of Colorado, Boulder); Nogami, Y. Nucl. Phys., B2: 459-69(1967).

Electromagnetic mixing of isospin eigenstates for the neutral mesons leads to charge-asymmetry effects in the N–N interaction. This is discussed in terms of a single-meson-exchange model in which the coupling constants are taken from SU_3 and from phenomenological estimates. Mixing of the vector mesons is considerably more important than mixing of the pseudoscalar mesons. The difference $(a_{nn}-a_{pp})$ between scattering lengths for the strong n-n and p-p interactions could be about –1.5 fm, when the n-p mass difference (which contributes about –0.5 fm) is also considered. Other charge-asymmetry effects which were estimated are much smaller. (auth)

37866 THE ΛΛ-HYPERNUCLEUS $^{6}He_{\Lambda\Lambda}$. Ali, S.; Bodmer, A. R. (IAEA, Trieste, Italy). Nuovo Cim. (10), 50A: 511-34 (Aug. 1, 1967).

The ΛΛ-hypernucleus $^{6}He_{\Lambda\Lambda}$ was studied in great detail by a three-body α-Λ-Λ model, using the results obtained from the α-α-Λ-Λ model of $^{10}Be_{\Lambda\Lambda}$. Apart from calculating the binding energy of $^{6}He_{\Lambda\Lambda}$, the shape dependence of various Λ-Λ potentials (including both hard-core and purely attractive types) on scattering length, effective range, etc., was also investigated. Different Λ-Λ potentials having different shapes but the same intrinsic range are found to be very nearly equivalent for the ΛΛ-hypernuclei. The results suggest that the alternative interpretation of the event reported by Danysz et al. as $^{11}Be_{\Lambda\Lambda}$ (all the theoretical analyses of this event have so far been based on the $^{10}Be_{\Lambda\Lambda}$ interpretation) deserves serious consideration. The possible implications of the results about the range of the Λ-N interaction are also discussed. (auth)

Particle Invariance Principles and Symmetries

37867 SURFACE IONIZATION ION SOURCES. Wilson, R. G. (Hughes Research Labs., Malibu, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 72-4(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

Recent achievements with iridium surface ionization ion sources are discussed. These sources can be used to produce ion beams of elements with ionization potentials from 5.5 to 6 V, e.e., the IIIA metals (Al, Ga, In and Tl), the rare earths, the heavier alkaline earths, and Li, in addition to the usual heavier alkalis. Ion beams of Li, Al, Ga, and In were produced. Ionization efficiencies, critical temperatures, current densities, and beam purities as measured by magnetic mass separation are discussed. An ion source design being employed for the IIIA metals is described briefly. (auth)

General

37868 (NP-16860) ON THE "LORENTZ-BASIS" OF THE POINCARE GROUP. Chakrabarti, Amitabha; Levy-Nahas, Monique; Seneor, Roland (Ecole Polytechnique, Paris (France). Centre de Physique Theorique). May 1967. 26p. Dep.

An explicit derivation is given for the matrix elements of the translation generators $P\mu$ of the Poincaré algebra with respect to the "Lorentz-basis," namely in terms of states which diagonalize the two Casimir operators of the homogeneous Lorentz group HLG). The results are given for the cases, mass $\mu > 0$ and $\mu = 0$, and for the latter for discrete and continuous spin. The transforms connecting the momentum and Lorentz bases are discussed, a detailed derivation being given for the zero mass discrete spin case. The matrix elements of $G_\mu = i[(\vec{N}^2 - \vec{M}^2, p_\mu)]$ are considered and several interesting aspects of the algebras generated by $\vec{N}$, $\vec{M}$, and $p'_\mu = (\epsilon_1 p_\mu + \epsilon_2 G_\mu)$ are discussed for the cases of positive as well as zero rest mass. A discussion of the results obtained is given. (auth)

37869 SELF-CONJUGATE BOSONS, INTERNAL SYMMETRY, AND CPT INVARIANCE. Kantor, Paul B. (State Univ. of New York, Stony Brook). Phys. Rev. Lett., 19: 394-5(Aug. 14, 1967).

A proof is outlined for a theorem concerning the possible representations for a system of self-conjugate bosons under the transformations of an internal symmetry group G. The conclusion that there must be a basis in which the representation is real is shown to follow from the existence of the CPT operator. (L.B.S.)

37870 ALL POSSIBLE SYMMETRIES OF THE S MATRIX. Coleman, Sidney; Mandula, Jeffrey (Harvard Univ., Cambridge, Mass.). Phys. Rev., 159: 1251-6(July 25, 1967).

A new theorem is proved on the impossibility of combining space-time and internal symmetries in any but a trivial way. The theorem is an improvement on known results in that it is applicable to infinite-parameter groups, instead of just to Lie groups. This improvement is gained by using information about the S matrix; previous investigations used only information about the single-particle spectrum. A symmetry group of the S matrix is defined as a group of unitary operators which turn one-particle states into one-particle states, transform many-particle states as if they were tensor products, and commute with the S matrix. Let G be a connected symmetry group of the S matrix, and let the following five conditions hold: (1) G contains a subgroup locally isomorphic to the Poincaré group. (2) For any $M > 0$, there are only a finite number of one-particle states with mass less than M. (3) Elastic scattering amplitudes are analytic functions of s and t, in some neighborhood of the physical region. (4) The S matrix is nontrivial in the sense that any two one-particle momentum eigenstates scatter (into something), except perhaps at isolated values of s. (5) The generators of G, written as integral operators in momentum space, have distributions for their kernels. Then, it is shown that G is necessarily locally isomorphic to the direct product of an internal symmetry group and the Poincaré group. (auth)

37871 REGGEIZATION OF INTERNAL SYMMETRIES. Salam, Abdus; Strathdee, J. (International Atomic Energy Agency, Trieste, Italy). Phys. Rev. Lett., 19: 339-43(Aug. 7, 1967). (IC-67/39).

A new approach to higher symmetries is suggested, particularly to the particle spectrum associated with them, based on a generalized partial-wave analysis of the conventional S matrix. (auth)

37872 THE RESOLUTION INTO MINIMAL IDEALS OF THE ENVELOPING ALGEBRA OF THE LIE-ALGEBRA OF THE ROTATION GROUP IN FOUR DIMENSIONS WITH SPIN 3/2. Rao, K. N. Srinivasa (Univ. of Mysore, India); Saroja, D. Proc. Nat. Inst., Sci. India, Pt. A, 32: 239-50(May 1966).

It has been proved by Madhava Rao et al., that the enveloping algebra of the Lie algebra of the Rotation Group R_n with half-odd-integral spin is the direct product of the Dirac algebra and another algebra called the ξ-algebra. A complete resolution into minimal ideals of the ξ-algebra A associated with R_4 is carried out. The basis of A is shown to be of rank 14, and corresponding to the resolution $1^2 + 2^2 + 3^2 = 14$ three primitive orthogonal idempotent elements of the center of A are determined, thus resolving A into a direct sum of two-sided ideals Ae_r (r = 1, 2, 3). Each of these Ae_r is then resolved into minimal left ideals giving rise to the irreducible representations of A. Mutually orthogonal idempotents generating these minimal left ideals are also determined. Since such a minimal ideal resolution for the Dirac algebra is known, the resolution of the enveloping algebra of the Lie-algebra of R_4 is solved. (auth)

37873 MAXIMUM-COMPLEXITY THEOREM FOR NONDYNAMICAL PARITY TESTS. Csonka, P. L.; Moravcsik, M. J. (Univ. of California, Livermore). Contract W-7405-eng-48. Nuovo Cim. (10), 50A: 422-30(Aug. 1, 1967). (UCRL-14992-T).

It is shown that in order to determine nondynamically the product of intrinsic parities in a four-particle reaction, it is sufficient to measure multipole moments of order only about half as high as the highest possible allowed by the spins of the participating particles. A procedure is outlined for the construction of such parity experiments. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstract 37897.

37874 NONCONSERVATION OF COMBINED PARITY AND NEUTRAL PARTICLE FLOWS IN WEAK INTERACTIONS. Shishkin, G. V. (Inst. of Nuclear Energetics, Minsk). Dokl. Akad. Nauk BSSR, 11: 118-21(Feb. 1967). (In Russian).

The Hamiltonian is written for the weak, four-fermion interaction: $b + d \rightarrow a + c$. A model is considered in which the nonconservation of combined inversion is due to the complex binding constants of the weak interaction. An expression is derived for an additional term which is proportional to the imaginary part of the axial-vector binding constant. The nonconservation of combined parity has no effect on the cross section of $\mu^+ \rightarrow e^+ + \nu + \nu'$. However, if neutral particles are involved in nature rather than charged particles, it can be shown that transverse polarization occurs in the beam perpendicular to the plane of the reaction. An expression is given for the degree of polarization. All effects taking place in weak interactions as a result of parity violation are extremely small (2 to 5%). A study of the polarization properties of electrons (positrons) from μ^+-decay would be of interest, since detection of the effect would indicate the nonconservation of combined parity and the existence of neutral particles simultaneously. (TTT)

37875 BARYON MAGNETIC MOMENTS AND ASSIGNMENT MIXING IN SU(6). Videira, A. L. L.; Renninger, G. H. (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 159: 1238-46(July 25, 1967).

An extension of the SU(6) static model is used to formulate a phenomenological analysis of the magnetic moments of the baryons and of the $J^P = (\frac{3}{2})^+$ baryonic resonance transition moments. The results are dependent on a parameter, characteristic of the model, the assignment mixing angle. The calculations of the magnetic moments are divided into two parts. In the first only the contribution of the vector-meson resonances is taken into account, while in the second this pole model is combined with part of the nonresonant contribution to the magnetic moments. The strength of the electric and magnetic couplings of the vector mesons to the nucleons is also calculated within the framework of the pole model. (auth)

37876 POSSIBLE CP VIOLATION IN $K^\pm \rightarrow \pi^\pm\pi^0\gamma$. Christ, N. (Columbia Univ., New York). Contract AT(30-1)-1932. Phys. Rev., 159: 1292-6(July 25, 1967). (NYO-1932-119).

A comparison of the decays $K^\pm \rightarrow \pi^\pm\pi^0\gamma$ may show relatively large CP-violating effects. A complete phenomenological analysis of these decays is given, including precise specification of the implications of T, CP, and CPT. A simple but reasonable model is developed which allows both prediction and theoretical interpretation of CP violation in these decays. (auth)

37877 SL(6,C) AND MESON DECAYS. Tripathy, K. C. (Univ. of Delhi); White, R. B. Phys. Rev., 159: 1374-7(July 25, 1967).

The relativistic extension of SU(6) proposed by Budini and Fronsdal based on SL(6,C) has been moderately successful in its application to baryon decays and to electromagnetic and hadron form factors. Work thus far on the three-meson interaction has been limited to the examination of an SL(2,C) model calculation by Rühl. The SL(6,C)-invariant three-meson vertex is examined. It is shown that the meson representation adopted by Fronsdal does not admit a three-meson vertex which is invariant under charge conjugation. An alternative representation first proposed by Rühl is examined and shown not to possess a coupling between three 35 multiplets. It is concluded that SL(6,C) forbids all meson decays, and that a modification of the theory must be made in order to describe these processes. (auth)

37878 NEUTRAL VECTOR-MESON PRODUCTION FROM AN ELECTRON-POSITRON COLLIDING BEAM AS A TEST OF C NONINVARIANCE IN THE ELECTROMAGNETIC INTERACTION. Chen, M. C. (Stanford Linear Accelerator Center, Calif. Idaho State Univ., Pocatello). Contract AT(04-3)-400. Phys. Rev., 159: 1228-31(July 25, 1967). (SLAC-PUB-243).

The production of a pair of identical neutral vector mesons from a colliding electron-positron beam is studied. Processes from both C-noninvariant and C-invariant interactions (i.e., 1γ and 2γ intermediate states) are considered, and differential and total cross sections are calculated. The correlation of the decay products from the vector mesons is also calculated for the C-noninvariant process. (auth)

37879 WEAK-ELECTROMAGNETIC DECAYS OF HYPERONS IN A BROKEN SU(3) ⊗ SU(3) MODEL. Carlstone, D. S.; Simmons, Walter A. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 159: 1320-4(July 25, 1967).

The weak (strangeness-changing)-electromagnetic decays of the hyperons of the type $B \rightarrow B\gamma$ are considered in a broken SU(3) ⊗ SU(3) model. Various sets of assumptions regarding the transformation properties of the particles, the breaking, and the Hamiltonian are examined and for each a set of sum rules for the decay amplitudes is obtained. (auth)

37880 THEORY OF STABILITY OF TENSOR OPERATORS UNDER PERTURBATIONS AND ITS APPLICATION TO PARTICLE PHYSICS. Sudarshan, E. C. G.; Mukunda, N. (Syracuse Univ., N. Y.). Contract AT(30-1)-3399. Phys. Rev., 158: 1424-32(June 25, 1967). (NYO-3399-99; SU-1206-99).

The perturbations of tensor operators due to symmetry breaking and consequent representation mixing are investigated. A group-theoretical stability principle, valid for an arbitrary (simple, compact) group is formulated, which in many cases assures the vanishing of the first-order perturbation when it is constrained to leave a certain component unaltered. The physically interesting case of unitary symmetry is discussed in detail. All previously known results are recovered and several new results are deduced. As an application the conditions under which the universality of the Cabibbo angles for leptonic decays is valid are discussed. (auth)

37881 ELECTROMAGNETIC MASSES OF BARYONS AND PSEUDOSCALAR MESONS. Riazuddin (Univ. of Islamabad, Rawalpindi, Pakistan); Fayyazuddin. Contract AT(11-1)-264. Phys. Rev., 158: 1447-50(June 25, 1967). (COO-264-361).

A new method to calculate all the electromagnetic masses of baryons and pseudoscalar mesons is proposed. It is assumed that medium-strong and electromagnetic mass splittings, respectively, come from scalar operators S_8 and S_3 which belong to nonchiral subalgebra U(3) × U(3) of Gell-Mann's SU(6). Therefore we write the Hamiltonian as $H = H_0 + \delta m S_8 + \delta M_e S_3$. Further, taking into account minimal electromagnetic interaction, it is shown that two types of contributions to electromagnetic mass differences are obtained. The first is the tadpole type and depends only on the single parameter $\delta m_e/\delta m$ for all electromagnetic mass differences of baryons and pseudoscalar mesons. The second is the conventional type from elastic electromagnetic form factors. In this way all electromagnetic mass differences of baryons as well as of pseudoscalar mesons can be explained in terms of a single parameter, except for the kaon, for which the proper sign is obtained but not the proper magnitude. (auth)

37882 T VIOLATION AND THE OFF-MASS-SHELL CORRECTIONS TO PROTON COMPTON SCATTERING. Lipshutz, Nelson R. (Univ. of Chicago). Contract AT(11-1)-264. Phys. Rev., 158: 1491-7(June 25, 1967). (COO-264-356; EFINS-66-105).

Although it is well known that a left-right asymmetry in the angular distribution of low-energy photons Compton-scattered from polarized protons may appear only if T is violated in the electromagnetic interactions, the order of magnitude of this asymmetry can be determined only on the basis of a specific model. A model is considered in which all T violation is contained in the off-mass-shell behavior of a model proton-photon vertex function, and dimensional arguments are used to determine the magnitude of the asymmetry in this case. On the basis of the model, an asymmetry of ~10% is predicted, and hence it is concluded that proton Compton scattering is a good test for the T invariance of hadron electrodynamics. (auth)

Applications (Strong)

Refer also to abstract 37778.

37883 (JINR-P2-3149) KVARKOVAYA MODEL' ADRONOV. (Quark Model of Hadrons). Malyuta, Yu. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 132p. (In Russian). Dep.

The quark model of strongly interacting particles is considered. This model is based on subgroups of the SL[3(2j + 1),C] group. The classification, mass spectra, form factors, decays, and hadron scattering are investigated. (auth)

37884 (JINR-P2-3391) NARUSHENNAYA SIMMETRIYA $SU_w(6)$ I DEVYATYI PSEVDOSKALYARNYI MEZON. (The Broken $SU_w(6)$ Symmetry and the Ninth Pseudoscalar Meson). Zaslavskii, A. N.; Ogievetskii, V. I.; Tybor, V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 15p. (In Russian). Dep.

The possible violations of the $SU_w(6)$ and $SU_x(6)$ are discussed. The mass formulas are derived. For baryons they are the same as in the static SU(6). However for mesons the results differ due to the well-known distinction in the $SU_w(6)$ classification of mesons according to conventional spin and W-spin. For all possible violations the mass of the ninth pseudoscalar meson turns out to be about 1400 GeV. The ninth pseudoscalar meson is to be identified with the E(1420)-meson, the recent most favorable spin-parity assignment for which is just 0^-. The results are valid also in the $SU_x(6)$ group that generalizes $SU_w(6)$ to the case of arbitrary binary reaction. (auth)

37885 ASYMPTOTIC SU(3) AND THE DECAY $\phi \to K\bar{K}$. Divakaran, P. P.; Pandit, L. K. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev. Lett., 19: 535-7(Aug. 28, 1967).

Saturating a Weinberg-type sum rule for the spectral functions entering the propagators of the isovector and the hypercharge currents [which follows from asymptotic SU(3)] by the ρ, the ω, and the φ, one obtains $\Gamma(\varphi \to K\bar{K}) = 3.1$ MeV. (auth)

37886 STRANGENESS + 1 BARYONS IN U(6) ⊗ U(6). Hendry, Archibald W.; Moorhouse, R. G.; Paton, J. E. (Rutherford High Energy Lab., Chilton, Eng.). Phys. Rev., 159: 1340-1(July 25, 1967). (RPP/A-19).

The allocation of I = 0, 1 strangeness-(+1) baryons to the 700 and 1134 representations of U(6) ⊗ U(6) is examined. The 1134 representation is favored if these baryons have $J^P = \frac{1}{2}^-, \frac{3}{2}^-$, respectively. (auth)

37887 FOUR-DIMENSIONAL SYMMETRY. Domokos, G. (Univ. of California, Berkeley). Phys. Rev., 159: 1387-1403 (July 25, 1967).

The symmetry of scattering amplitudes at vanishing momentum transfer is studied. It is shown that the little group of the Poincaré group corresponding to vanishing four-momentum (isomorphic to the homogeneous Lorentz group, or, by analytic continuation, to the four-dimensional rotation group) is in general not a symmetry of the scattering amplitude. However, the spectrum of the amplitude is classified according to the larger symmetry. Regge poles occur in families; the members of the family follow the first one in integer steps at vanishing momentum transfer and are classified according to a new quantum number derived from the higher symmetry. A one-parameter "mass formula" describing the deviation of the slopes of Regge trajectories from the value required by the higher symmetry is derived. The theory is applied to the problem of the high-energy scattering of particles of arbitrary mass, and leads to an unambiguous asymptotic expression for the scattering amplitude. The implications of the new symmetry for the spectrum of hadrons are analyzed. The predicted new Regge trajectories lead to observable particles and resonances; their coupling strength is determined by the symmetry in terms of the parameters of the "parent" trajectories. In particular the N'(1400) resonance is assigned to the second "daughter" of the N_α trajectory; the symmetry breaking turns out to be small, and the decay width of N'(1400) is computed in satisfactory agreement with the experimental result. (auth)

37888 INTRINSIC ORBITAL ANGULAR MOMENTUM AND W SPIN. Lipkin, Harry J. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev., 159: 1303-5(July 25, 1967).

The W-spin classification is extended to include states of quarks and antiquarks with finite intrinsic orbital angular momentum (orbital excitation). The conservation of this extended W spin is shown to be automatically incorporated in many quark-model treatments, and some applications are discussed. (auth)

37889 TWO-DIMENSIONAL RELATIVISTIC QUARK MODEL WITH EXACT SOLUTIONS. Coleman, R. A.; Moffat, J. W. (Univ. of Toronto). Phys. Rev., 159: 1306-9(July 25, 1967).

A relativistic two-dimensional quark model is developed in which zero-mass quarks interact through a massive, neutral vector boson. Exact solutions for the quark fields are found, and vector and axial-vector current densities are constructed. An SU(3) × SU(3) algebra of the time components of these currents is investigated by explicitly calculating the equal-time commutators. It is found that all noncanonical terms (Schwinger terms) are absent. (auth)

37890 UNITARY RESTRICTIONS ON SCATTERING AMPLITUDES FROM DYNAMICAL GROUPS. Balachandran, A. P.; Gyuk, I.; Pakvasa, S.; Raman, K. (Syracuse Univ., New York). Contract AT(30-1)-3399. Phys. Rev., 159: 1310-20(July 25, 1967). (NYO-3399-73).

A method is discussed for deriving restrictions consistent with unitarity on partial-wave amplitudes for two-body reactions, starting with a dynamical group which is a good symmetry only for certain three-point functions. As a simple illustration the application to the quark-antiquark-15 vertex in U(2,2) is worked out in detail. The method is applied to the 364-364*-143 vertex in U(6,6) and sum rules are derived for the partial-wave amplitudes for baryon-antibaryon annihilation into two mesons. The results are seen to be explicitly consistent with unitarity and with the threshold behavior normally expected for partial-wave amplitudes. (auth)

37891 ALGEBRAIC STRUCTURE OF SUPERCONVERGENCE RELATIONS. Bardakci, K.; Segre, G. (Univ. of California, Berkeley). Phys. Rev., 159: 1263-8(July 25, 1967).

A general analysis of the matrix element of a vector current in the infinite-momentum frame is given. Use of some simple group-theoretical techniques is shown to be helpful in obtaining a multipole decomposition for the current. The forward-scattering superconvergence relations for vector mesons are then analyzed using these methods. Keeping only $\Delta J = 0,1$, the first two terms in the multipole expansion, it is shown that these superconvergence relations lead to a covariant, collinear SU(3) × SU(3). (auth)

37892 TWO-NUCLEON INTERACTION AS A RESEARCH TOOL IN PARTICLE PHYSICS. Moravcsik, Michael J. (Harvard Univ., Cambridge, Mass. Univ. of California, Livermore). Rev. Mod. Phys., 39: 670-80(July 1967).

From American Physical Society, Nucleon-Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

Knowledge of the two-nucleon interaction can be used as a proving ground for general theories of elementary particles.

Within this context three aspects of the nucleon–nucleon problem are examined: the tests of some group theoretical schemes through the nucleon–nucleon interaction; a summary of the status of test of general conservation laws; and an attempt to investigate the general analyticity structure of the S matrix through the two-nucleon interaction. (auth)

37893 IDEAS ON NEW EXPERIMENTS ON POLARIZED TARGET. Lapidus, L. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Rev. Mod. Phys., 39: 689-94(July 1967).

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla. See CONF-670302.

A possible application of polarized proton targets and polarized proton and antiproton beams to the direct testing of T, P, C invariance and the CPT theorem is considered. Procedure for direct determination of the T-violated amplitude T from experimental data is given. Deviations from symmetry properties for polarization tensors in elastic scattering due to the bremsstralung effect are considered. The P invariance can be tested both in the up–down asymmetry measurement and in the total cross section measurements using the polarized beam and the polarized target. The measurement of the total polarization cross section σ_{p1p2} is of interest for testing higher isotopic symmetries. (auth)

37894 A CLASS OF SU(n) CROSSING MATRICES. Capps, Richard H. (Northwestern Univ., Evanston, Ill.). Ann. Phys. (N. Y.), 43: 428-35(July 1967).

A simple expression is derived for the meson–baryon scattering, u-channel crossing matrix, when the mesons are associated with the regular representation of SU(n), and the baryons with any representation for which the MBB interaction is unique. The crossing matrix elements are ratios of simple polynomials. Many of the techniques employed are useful for studying other crossing matrices as well. (auth)

37895 RESONANCE POLES IN A SIMPLE MODEL OF S-WAVE PSEUDOSCALAR-MESON–BARYON SCATTERING. Logan, R. K.; Wyld, H. W. Jr. (Univ. of Illinois, Urbana). Phys. Rev., 158: 1467-70(June 25, 1967).

In an earlier work a numerical calculation was made of S-wave pseudoscalar-meson–baryon scattering in a simple broken-SU(3) model based on a static vector-meson exchange potential and coupled-channel Schrödinger equations. These calculations are extended to finding the location of the poles of the scattering matrix in the multisheeted complex energy plane and finding the motion of these poles as the strength of the potential is varied. Particular attention is paid to the behavior of the poles when the potential strength is such that there is a resonance closed to a threshold. (auth)

37896 ALPHA–BARYON OCTET AND THE POSSIBLE EXISTENCE OF A NEW SINGLET. van der Merwe, P. du T. (Atomic Energy Board, Pelindaba, South Africa). Nuovo Cim. (10), 50A: 458-66(Aug. 1, 1967).

A multichannel analysis of the resonant F-wave $\frac{1}{2}^+$ baryon octet-0^- meson octet scattering on the basis of the dynamical mechanisms of Agarwal and Cook–Lee is presented. The analysis provides an understanding of the $\frac{5}{2}^+$ alpha-baryon octet and suggests the existence of a new $\frac{5}{2}^+$ baryon singlet for a reasonable choice of the F/D ratios. The implications of these results regarding the higher-symmetry scheme W_3 are briefly discussed. A further result of the analysis is the prediction of the $(\overline{B}_8 B_8 P)$ mixing parameter as 0.43. This result is compared to the experimental value calculated from branching ratios. (auth)

37897 PARTIALLY CONSERVED AXIAL-VECTOR CURRENT, CHARGE COMMUTATORS, OFF-MASS-SHELL CORRECTION, AND THE BROKEN SU(3) SYMMETRY. Matsuda, S.; Oneda, S. (Univ. of Maryland, College Park). Phys. Rev., 158: 1594-9(June 25, 1967).

It is pointed out that the extension of the PCAC (partially conserved axial-vector current) relation $\partial_\mu A_\mu^\pi = C_{\pi\phi}\phi^\pi$ to $\partial_\mu A_\mu^K = C_{K\phi}^K$ and the use of charge commutators typified by $A_K = [V_K, A_\pi]$ are useful in the study of broken SU(3) symmetry. The use of the $\partial_\mu A_\mu^K = C_{K\phi}^K$ condition usually confronts us with a considerable off-mass-shell extrapolation $m_K \to 0$. However, by using the above charge commutators and the approximation it is proposed that the off-mass-shell extrapolation $m_K \to 0$ may be replaced by a more comfortable one, $m_\pi \to 0$, effectively to first order in the symmetry-breaking interaction. This approach is applied to the study of the SU(3) symmetry breaking. Encouraging results were obtained in the case of $V \to P + P$ (i.e., $K^* \to K + \pi$ and $\rho \to \pi + \pi$) decays and in the direct determination of f–f′ mixing angle from their decay widths. An estimate of the off-shell extrapolation $m_K \to 0$ compared with the case $m_\pi \to 0$ is also made. Another useful application of the above charge commutators is for the weak leptonic decays. A set of sum rules is derived for the axial-vector coupling constants of the leptonic decays of hyperons which seem to give new insight into the Cabibbo theory of leptonic interactions. (auth)

37898 SELF-CONSISTENT EQUATIONS AND SELF-COUPLING OF VECTOR MESONS. Fleischman, O.; Musto, R.; O'Raifeartaigh, L.; Rao, P. S. (Syracuse Univ., N. Y.). Phys. Rev., 158: 1589-94(June 25, 1967).

A system of n vector mesons in self-interaction is considered, and the problem of deducing the existence of a symmetry group for the interaction by the use of self-consistency equations is investigated. Two results are established. The first is that a technical condition of complete antisymmetry for the coupling constants, which was used as an assumption in an earlier "bootstrap" demonstration of the existence of a symmetry group by Cutkosky, can be derived from other assumptions. The latter have an immediate physical interpretation and for this reason may be more plausible. Secondly, it is shown that for the physically interesting case n = 8 at any rate, the existence of the symmetry group for the interaction follows also from the so-called Smushkevich principle. (auth)

37899 BOOTSTRAP ALGEBRAS FOR BARYONS AND MESONS. Patil, Sharashchandra H. (Univ. of California, Los Angeles). Phys. Rev., 158: 1580-8(June 25, 1967).

A dynamical model based on linearized D functions leads to a series of relations called the bootstrap algebras. Under specific conditions these algebras imply that the $\frac{1}{2}^+$ baryons must belong to a representation of the Lie algebra whose structure constants are given by the vector-meson coupling constants. If the u-channel forces admit of a static approximation, the algebras lead to consequences which are the same as those of the spin–internal-symmetry groups, while avoiding the usual difficulties encountered for the couplings of these groups. Several such systems leading to consequences of groups like SU(6), Sp(16), and the strong-coupling group are discussed. The results are shown to be applicable to meson-meson scattering even though the light pseudoscalars are exchanged in the u channel. It is found that the pseudoscalar-meson–vector-meson couplings in the SU(6) model and the strong-coupling model are in remarkable agreement with each other. (auth)

37900 APPROXIMATE SU_3 AND ITS NONRELATIVISTIC LIMIT. Fleischman, O.; Roman, P. (Boston Univ.). Phys. Rev., 158: 1560-5(June 25, 1967).

Hadron states with given parity and a complete set of Poincaré and SU_3 labels are discussed in purely Lie algebraic terms. Since P must vanish for these states, the mass operator becomes $M = c^{-1}(-P_\mu P^\mu)^{\frac{1}{2}} = c^{-1}P_0$. Having thus resolved the question of whether the Gell-Mann–Okubo splitting of M should be formulated in terms of the Hamiltonian $H = cP_0$ or M itself (which is $c^{-1}P_0$ for these states), the implied commutators of P_0 with the SU_3 generators are considered. These commutators are taken as given, but it is not assumed that $P_0 = P_0^{(0)} + P_0^{(1)}$, with $P_0^{(0)}$ an SU_3 scalar and $P_0^{(1)} \ll P_0^{(0)}$. The nonrelativistic Galilean limit $c \to \infty$ is explored for any particle representation of the Poincaré algebra, and it is concluded that P_0 is made up of two parts, with $c^{-1}P_0^{(0)} \to M$, the Galilean mass, and $cP_0^{(1)} \to -H_0$, the internal energy. If it is assumed that the fundamental commutators of cP_0, P_0, and $c^{-1}P_0$ with the SU_3 generators remain finite as $c \to \infty$, one obtains the limit of the Gell-Mann–Okubo formulation. The only such limit describes hadrons with the same spin and parity as if they were eigenstates of a single isolated system of (undefined) nonrelativistic particles. M is an SU_3 scalar, while H_0 either is a scalar or has eigenvalues given by the familiar Gell-Mann–Okubo formula, but now obtained as an exact rather than a first-order perturbation result. (auth)

37901 INTERMEDIATE-COUPLING MODELS FOR HYPERON ISOBARS. Rangwala, A. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 158: 1450-3(June 25, 1967).

Two intermediate-coupling groups valid for both the nucleon and the hyperon isobars are suggested. For the nucleon isobars these reduce to the group SU(4). Predictions of these groups for the hyperon coupling-constant ratios and magnetic moments are obtained. It is found that, in general, the results are consistent with the static SU(6) theory. (auth)

37902 MASS FORMULA AND "BROKEN SU(3)" IN AN ASSOCIATIVE ALGEBRA. Boehm, Arno (Syracuse Univ., N. Y.). Contract AT(30-1)-3399. Phys. Rev., 158: 1408-13(June 25, 1967). (NYO-3399-94).

An associative algebra, which contains the enveloping algebra of the Poincaré group and the enveloping algebra of SL(3,c), is considered. Its reduction with respect to irreducible representations of SU(3) is studied and a mass formula is derived, which contains the mass formula for mesons of "broken" SU(3) as a special case. The results are compared with experimental data. (auth)

37903 NONCOMPACT NONINVARIANCE GROUPS. Biswas, S. N.; Novozhilov, Yu. V.; Saxena, R. P. (Univ. of Delhi). Phys. Rev., 158: 1380-2(June 25, 1967).

A sequence of noncompact intermediate-coupling groups was constructed starting from the static strong-coupling group of Cook, Goebel, and Sakita. Our basic assumption involves the use of successive approximations to the meson currents in the inverse power of the strong-coupling constants. In particular, in the first approximation the intermediate-coupling group ISL (n,C) was obtained from SU (n) ⊗ $T_n^{z=1}$ as the basic strong-coupling group. Further, as a specific use of such groups meson-baryon scattering was considered. (L.B.S.)

37904 CONFIGURATION MIXING IN THE SU_6 COMPOSITE MODEL WITH ORBITAL EXCITATION. Castilho Alcaras, J. A.; Leal Ferreira, P. (Instituto de Fisica Teorica, Sao Paulo, Brazil). Nuovo Cim. (10), 50A: 668-73(Aug. 1, 1967).

The mixing in the baryonic states (the baryons being considered as 3-fermion quark structures) is studied in the framework of nonrelativistic SU(6) quark model in such a way that, besides the dominant $\underline{56}$ with an L = 0 part, admixtures of unitary octet (decuplet) contributions coming from the 20- and the 70-dimensional representations of SU(6) are taken into account with the L values allowed by the L–S coupling to J = ½ for the octet and J = 3/2 for the decuplet. As an illustration, an analysis of the mixing effects in the baryon magnetic moments and in the semileptonic decays is given. Also the baryon decuplet magnetic moments and the semileptonic decays are calculated, and some relations between the $[(G_A/G_V)_{BB'}]_{np}$ ratios and F and D are obtained. (J.F.P.)

37905 VECTOR–PSEUDOSCALAR MESON BOOTSTRAP AND DYNAMICAL SYMMETRIES. Conway, P. D. (Cambridge Univ., Eng.). Nuovo Cim. (10), 50A: 467-76(Aug. 1, 1967).

The problem of the dynamical induction of symmetries by the bootstrap mechanism is reviewed. Polkinghorne's model of interacting vector and pseudoscalar mesons is considered in the Reggeized N/D formalism of Abers and Zachariasen and the Lie group condition derived. (auth)

Quantum Field Theories

Refer also to abstracts 37736, 37753, 37818, and 37934.

37906 (IC–67/58) SELF-COUPLED REPRESENTATIONS OF THE LORENTZ GROUP AND INFINITE-COMPONENT FERMI FIELDS. Stoyanov, D. Tz.; Todorov, I. T. (International Centre for Theoretical Physics, Trieste (Italy)). July 1967. 59p. Dep.

A self-contained exposition is given of the theory of infinite-component Majorana fields. The problem of spin and statistics for such fields is specially analyzed. More general possibilities for infinite-component Fermi fields (than those transforming under an irreducible self-coupled representation of the Lorentz group) are indicated. The formalism of ladder representations (involving Bose creation and annihilation operators) is used throughout. Most of the results are known but are presented in a unified way, their derivation sometimes being simplified. Among the few new points mentioned are the discussion of the quantization of Majorana fields which specially concerns the Fourier components with space-like momenta; and the location of singularities of the matrix elements of some infinite-dimensional representations of SL(2,C) for complex values of the group parameters and their relation to the failure of the axiomatic proof of TCP and spin and statistics for infinite-component fields. (auth)

37907 (JINR–E2-3347) POSITIVE FUNCTIONALS ON ALGEBRAS OF TEST FUNCTIONS FOR QUANTUM FIELDS. Lassner, G.; Uhlmann, A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 12p. Dep.

It is shown that the *-algebra R of test functions for a quantum field is reduced, i.e., for each b∈R, b ≠ 0, there exists a positive continuous linear functional W(a) on R with W(b) ≠ 0. (auth)

37908 ELECTROMAGNETIC INTERACTION OF THE BARGMANN–WIGNER FIELD WITH SPIN 1/2. Gupta, Suraj N.; Repko, Wayne W. (Wayne State Univ., Detroit). Phys. Rev., 159: 1082-3(July 25, 1967).

It is shown that the Bargmann–Wigner multispinor field for particles of spin ½ gives the usual result for the magnetic moment, provided it is ensured that the auxiliary field appearing in the Lagrangian formulation remains vanishing in the presence of electromagnetic interaction. (auth)

37909 COMMUTATION RELATIONS AND FIELD DEPENDENCE OF VECTOR AND TENSOR CURRENTS. Frishman, Y. (Stanford Linear Accelerator Center, Calif.). Phys. Rev., 159: 1428-30(July 25, 1967). (SLAC-PUB-257).

It is shown, directly from proper Lorentz invariance and a positive Hilbert-space metric, that the vacuum expectation value $\langle 0|[j_0(\underline{x}), j_k^\dagger(y)]|0\rangle$ cannot vanish unless $j_\mu(x)|0\rangle = j_\mu^\dagger(x)|0\rangle \equiv 0$. Neither locality nor Källén–Lehmann-type representations are needed. The same is demonstrated for $\langle 0|[S_{kl}(x), S_{lm}^\dagger(y)]|0\rangle$, for any antisymmetric tensor $S_{\mu\nu}$. The explicit dependence of j_μ and $S_{\mu\nu}$ on the fields with which they interact is an immediate consequence in our approach. Similarly, it is easy to show that χ(x), $\chi(x) = \partial_\mu j^\mu(x)$, does not commute with $j_0^\dagger(y)$ for $y_0 = x_0$, unless $\chi(x)|0\rangle = \chi^\dagger(x)|0\rangle \equiv 0$. (auth)

37910 RELATION BETWEEN Z = 0, BOOTSTRAPS, AND THE STRONG-COUPLING LIMIT OF A MODEL FIELD THEORY. Deshpande, N. G. (Northwestern Univ., Evanston, Ill.). Phys. Rev., 159: 1342-5(July 25, 1967).

The unitarity equations for the Ruijgrok–Van Hove model are set up, and it is shown that the strong-coupling solution is identical to the Z = 0 solution previously obtained by the author. The relation between the strong-coupling solution and the reciprocal-bootstrap solution, defined in terms of a solution of eigenvalue equation of the crossing matrix, is demonstrated. The solution thus obtained possesses a higher symmetry than is contained in the Hamiltonian—a feature of the usual strong-coupling solution—although the isobar spectrum is not infinite in this model. (auth)

37911 TOWERS AS SETS OF COMPOSITE PARTICLES AND TROUBLE WITH INFINITE-COMPONENT FIELD THEORIES. Halpern, M. B. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 159: 1328-30(July 25, 1967).

It is argued in perturbation theory that if an infinite number of particles with mass and spin going to infinity (tower) is to be consistent with unitarity in the cross channel then, in general, all the particles in the tower (except perhaps the lowest) must be composite; that is, as the coupling is turned off, most or all of the tower must disappear. Because of this, definite trouble with unitarity is indicated for infinite-component field theories with towers in the free Lagrangian. (auth)

37912 INELASTIC UNITARITY IN THE BETHE–SALPETER EQUATION AND THE RELATED SELF-ENERGY PROBLEM. Saenger, Robert (Stanford Linear Accelerator Center, Calif.). Contract AT(04-3)-515. Phys. Rev., 159: 1433-46(July 25, 1967). (SLAC-PUB-258).

The Bethe–Salpeter equation in the ladder approximation for spinless particles is treated for $2\mu > KE > \mu$ where an explicit expression is derived for $(4\pi/k)\,\mathrm{Im}f(0)$. In order to achieve inelastic unitarity and maintain a precise correspondence to Feynman graphs, a nonlinear propagator equation is formulated which approximates Dyson's equation. It is shown that this equation can be solved for any coupling strength and that the resulting propagators exhibit the structure of a Lehmann spectral representation. (auth)

37913 BREAKDOWN OF LORENTZ INVARIANCE. Pavlopoulos, T. G. (Navy Electronics Lab., San Diego, Calif.). Phys. Rev., 159: 1106-10(July 25, 1967).

The special theory of relativity results from the postulation of invariance under coordinate transformation of the hyperbolic wave equation $\Box\psi \equiv \nabla^2\psi - (1/c^2)(\partial^2\psi/\partial t^2) = 0$, and it is required that all laws of physics (except perhaps general theory of relativity) be invariant under Lorentz transformations. Divergencies in present relativistic field equations may be removed by considering more general wave equations, for example, $-l_0^2\nabla^4\psi + \nabla^2\psi - (1/c^2)(\partial^2\psi/\partial t^2) = 0$. This equation introduces a universal length $l_0 \approx 10^{-13}$ cm as a second invariant and destroys Lorentz invariance except as an approximate invariance. Some theoretical and experimental consequences of this four-dimensional wave equation are discussed. (auth)

37914 DISEASES OF INFINITE-COMPONENT FIELD THEORIES. Abers, Ernest; Grodsky, I. T.; Norton, Richard E. (Univ. of California, Los Angeles). Phys. Rev., 159: 1222-7 (July 25, 1967).

Examples are presented of local, covariant field theories for which the familiar spin and statistics and PCT theorems do not apply. The field theories employ infinite-dimensional representations of the homogeneous Lorentz group and are formulated in terms of fields satisfying local commutation rules. Since the existing proofs of PCT and spin and statistics assume fields with a finite number of components, our conclusions do not violate these theorems. The existence of solutions with spacelike momenta is discussed. (auth)

37915 POSSIBILITY OF FASTER-THAN-LIGHT PARTICLES. Feinberg, G. (Rockefeller Univ., New York). Phys. Rev., 159: 1089-1105(July 25, 1967).

The possibility of describing, within the special theory of rela-

tivity, particles with spacelike four-momentum is considered, which therefore have velocities greater than that of light in vacuum. The usual objections to such particles are discussed, and they are found to be unconvincing within the framework of relativistic quantum theory. A quantum field theory of noninteracting, spinless, faster-than-light particles is described. The field theory is Lorentz-invariant, but must be quantized with Fermi statistics. The associated particle theory has the property that the particle number is not Lorentz-invariant, and the no-particle state is not Lorentz-invariant either. Nevertheless, the principle of relativity is satisfied. The Lorentz invariance implies a relation between emission and absorption processes, in contradiction to the usual case. Some comments are made about the problem of introducing interactions into the field theory. The limiting velocity is c, but a limit has two sides. (auth)

37916 SPECTRAL REPRESENTATION FOR THE SPIN-3/2 RARITA–SCHWINGER FIELD. Raszillier, I. (Inst. of Physics, Bucharest); Schiller, D. H. Rev. Roum. Phys., 12: 437-55(1967).

The spectral representations for the two-point functions, the vacuum expectation value of the anticommutator and the propagator of the Rarita-Schwinger field for spin $^3/_2$ are derived in a group theoretical manner. The implications of invariance under CPT, CP and P, as well as those of the supplementary conditions are investigated in detail. (auth)

37917 GROUND STATE OF THE URFERMIONS IN LATTICE SPACE. Weidemann, Erich G.; Bopp, Fritz (Univ., Munich). Z. Phys., 204: 311-38(1967). (In German).

The energy of the Dirac sea of interacting urfermions in a lattice space with Z^3 points is calculated using Heisenberg's Hamiltonian and a two-particle approximation which is a variational calculation with the test function $|\varphi\rangle = e^{i\eta}|D_0\rangle$; $|D_0\rangle$ is the Dirac sea without interaction, $\eta = (\psi\dagger\psi)$ a bilinear expression of the urfermion creation and annihilation operators. The same result is obtained by a BCS-calculation. Beyond that, one derives simple lower and upper bounds for the energy. Excited states are considered consisting of a particle-antiparticle pair with the energy $E = 2\sqrt{\omega^2 + M^2}$. The mass M and the interaction constant W are connected by the equation $(4W)^{-1} = Z^{-3}\Sigma(\omega^2 + M^2)^{-\frac{1}{2}}$. For usual masses $4W \approx \sqrt{Z/l}$ (l a nuclear length). Methods to improve the results are discussed. (auth)

37918 TROUBLE WITH FUBINI'S SINGLE-PARTICLE POLE SOLUTION TO SUPERCONVERGENCE RELATIONS. Grodsky, I. T. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Lett., 25B: 149-52(Aug. 7, 1967). (IC-67/45).

It is demonstrated that to date there exist no known solutions to the infinite class of sum rules arising from superconvergence conditions consistent with the usual prescriptions of S-matrix theory and/or finite component field theory. (auth)

37919 ASYMPTOTIC BEHAVIOR OF MANDELSTAM TYPE DIAGRAMS WHEN SPINS ARE TAKEN INTO ACCOUNT. I. Avakov, G. V. (All-Union Inst. of Science and Technical Information, USSR). Zh. Eksp. Teor. Fiz., 53: 389-400(July 1967). (In Russian).

The asymptotic behavior of diagrams of the Mandelstam type (i.e. diagrams leading to the appearance of moving branch points in the complex j plane) is studied by straightforward calculation of the Feynman integrals by taking into account the particle spins. (auth)

37920 NONLOCAL QUANTUM FIELD THEORY. Kirzhnits, D. A. (Lebedev Inst. of Physics, Moscow). Usp. Fiz. Nauk, 90: 129-42(Sept. 1966). (In Russian).

A short review of the present state of nonlocal field theory is presented. The local theory of elementary particles is based on three main postulates: relativity, quantum mechanical nature of elementary particles, and the principle of point interaction or of microscopic causality. Difficulties with the divergences of local theory indicate that the third postulate, that of localness, is false. The introduction of a form factor F into local expressions of coordinates and moments can overcome some of the difficulties of applying nonlocal theory in a self-consistent fashion. Nonlocal theory can only pretend to a rough preliminary description of nonlocal effects. Its strength lies in its indefiniteness. "Earlier" and "later" lose their meaning in nonlocal theory. However, ideas have been advanced to limit the violation of causality to an invariant region of very small length. In principle, most of the problems of nonlocal theory can be solved. The only unsolved problem is the problem of macroscopic causality, which is still far from being solved. Nonlocal theory should not lead to results contradicting space and time succession on a large scale, as is observed in actuality. (TTT)

37921 DIRAC–SCHWINGER COVARIANCE CONDITION IN CANONICAL THEORIES. Brown, Stanley G. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 158: 1608-17(June 25, 1967).

The simplest form of the Dirac–Schwinger condition for covariance of field theories relates the equal-time commutator of the energy density to the momentum density; this form has been shown by Schwinger to hold for a large class of theories. Two new proofs of this theorem for "canonical theories" are presented, i.e., theories in which canonical commutation relations may be assumed consistently with the constraint equations. The first new proof, which is valid for all canonical theories to lowest order in $\hbar$, shows that the theorem holds for canonical theories because (1) all field components transform (under Lorentz transformations) explicitly as tensors or spinors and (2) the simplicity of the commutation relations prevents additional terms from appearing in the energy-density commutator. The second new proof, which is valid to all orders in $\hbar$, consists of the direct evaluation of the energy-density commutator; this proof is given for a "preferred subclass" of canonical theories; in order for the theorem to apply (to all orders in $\hbar$) to canonical theories outside this subclass, one must set $\delta_1\delta^3(0) = 0$ on symmetry grounds. In an Appendix, the close relationship between the Dirac–Schwinger condition and the integrability condition required for consistency of the Schwinger–Tomonaga covariant formulation of field theory is shown in the interaction picture. (auth)

37922 RELATION OF NORMAL-ORDERING METHODS TO LINKED DIAGRAMS. Marburger, J. H. (Univ. of Southern California, Los Angeles). Phys. Rev., 158: 1557-60(June 25, 1967).

The normal-ordering method of Heffner and Louisell is extended to apply to anticommuting operators and systems with nonquadratic Hamiltonians. This extended method is shown to yield coupled ordinary differential equations for quantities which are sums of all linked-diagram contributions having the same external line configuration. (auth)

37923 CURRENT COMMUTATORS IN QUANTUM ELECTRODYNAMICS. Nagylaki, Thomas (California Inst. of Tech., Pasadena). Contract AT(11-1)-68, Phys. Rev., 158: 1534-6 (June 25, 1967). (CALT-68-111).

The operator structure of the singular terms in the equal-time commutator of space and time components of the electromagnetic current is investigated in perturbation theory by establishing a connection with Feynman diagrams. It is made very plausible that the singular term is a c number. Some remarks are made about the same problem in the electrodynamics of a spinless particle. (auth)

37924 HIGH-ENERGY BEHAVIOR IN QUANTUM FIELD THEORY. I. STRICTLY LOCALIZABLE FIELDS. Jaffe, Arthur M. (Stanford Univ., Calif.). Phys. Rev., 158: 1454-61 (June 25, 1967). (SLAC-PUB-249).

The notion of a field which is strictly localizable within a region of space-time is introduced. The restrictions strict localizability imposes on the high-energy behavior of fields are investigated, and it is found that it leads to an upper bound on the growth of a field in momentum space. This bound allows the off-mass-shell vacuum expectation values to grow in momentum space faster than any polynomial. Furthermore, it turns out that no maximum rate of growth exactly saturates our bound. In addition, strictly localizable fields need not be Schwartz distributions. However, the usual distribution fields are strictly localizable fields of a special type. We formulate a strictly local field theory in precise mathematical terms. Finally, simple examples of strictly localizable fields that are not distributions are discussed. (auth)

37925 SPECULATIONS ON PARTICLES, SUPERSELECTION RULES, AND COMPOSITES. Roman, P. (Boston Univ.). Phys. Rev., 158: 1377-9(June 25, 1967).

The occurrence of baryon number, electric charge, lepton number, and their association with mass, spin, and internal quantum numbers is investigated from the viewpoint of measurability in quantum field theory and on the basis of a very general composite-particle hypothesis. From this scheme, a very satisfactory classification of all permissible particle states is obtained. The special role played by $s \geq 1$ massless, neutral, structureless bosons is pointed out. (auth)

37926 MATRIX REPRESENTATIONS OF FIELDS. Scharfstein, H. Phys. Rev., 158: 1254-60(June 25, 1967).

A simple representation of operators, satisfying equal-time commutation relations which can be obtained from Schwinger's action principle, is studied. Assuming that charge is conserved and considering trilinear interactions in a Lagrangian context, the fields associated with the representation are shown to satisfy a number of selection rules. (auth)

37927 COMPOSITENESS CRITERION ON AN UNPHYSICAL SHEET. Hagen, C. R. (Univ. of Rochester, N. Y.). Contract AT(30-1)-875. Nuovo Cim. (10), 50A: 545-61(Aug. 1, 1967). (UR-875-181).

The renormalization of a quantized field for which there exists no corresponding particlelike excitation is discussed in general terms. Since the absence of a single-particle term in the Lehmann representation of the propagator is associated with the passage of the pole which represents the discrete-state contribution through the elastic threshold, one can continue to carry out mass and wave function renormalization in the usual way by following the motion of the relevant pole to an unphysical sheet. It is shown that this leads to a definition of Z_3 for virtual states which allows it to be negative and unbounded, a circumstance which is in sharp contrast to the corresponding result for physical particles. The Z = 0 limit is discussed, it being demonstrated that an "elementary virtual particle" becomes a "composite virtual particle" in that limit. (auth)

37928 FEYNMAN DIAGRAMS FOR THE YANG-MILLS FIELD. Faddeev, L. D.; Popov, V. N. (Mathematical Inst., Leningrad). Phys. Lett., 25B: 29-30(July 24, 1967).

Feynman and De Witt showed that the rules must be changed for the calculation of contributions from diagrams with closed loops in the theory of gauge invariant fields. They suggested also a specific recipe for the case of one loop. A simple method is proposed for calculation of the contribution from arbitrary diagrams. The method of Feynman functional integration is used. (auth)

37929 CLASSICAL THEORY OF LORENTZ VECTOR FIELDS. Goldberg, I.; Marx, E. (Clarkson Coll. of Tech., Potsdam, N. Y.). Nuovo Cim. (10), 50A: 477-92(Aug. 1, 1967).

Several problems inherent in the theory of vector fields is analyzed. The first part deals with the separation of the Lorentz vector field into spin-1 and spin-0 parts; it is observed that the latter enters the k-space expansions of the energy-momentum vector, the charge and the angular momentum tensor with an additional minus sign, when compared with the ordinary scalar field. Consequently, the energy is not positive definite, and a prescription is given to overcome this difficulty. The theory is then extended to include interactions with the electromagnetic field, and a brief discussion of its quantization follows. (auth)

Scattering Theory

Refer also to abstracts 37119, 37842, and 38409.

37930 (IC-67/36) MACROSCOPIC CAUSALITY. Blokhintsev, D. I. (International Centre for Theoretical Physics, Trieste (Italy)). June 1967. 55p. Dep.

The S-matrix is investigated in light of its importance in future developments of the theory of elementary particles. The main properties of the S-matrix are outlined; unitarity, relativistic invariance and causality. The formulation of requirements of causality directly imposed on the S-matrix with recourse to the concept of field is first considered. The possibility of description of a collision process by means of packets localized in space and time is next considered as a necessary precondition for the formulation of macrocausality conditions. The conditions of microcausality are then formulated. (L.B.S.)

37931 (IC-67/63) GREEN'S FUNCTIONS FOR REGGE TRAJECTORIES. Delbourgo, R.; Rashid, M. A.; Salam, Abdus; Strathdee, J. (International Centre for Theoretical Physics, Trieste (Italy)). July 1967. 6p. Dep.

The problem of writing a causal Green function in momentum space, which should describe the propagation of the trajectory, when given the trajectory function describing the path of a Regge pole in the J-plane, $J = \alpha(W)$, where $\alpha(W)$ satisfies a dispersion relation, is considered. (J.F.P.)

37932 (IPNO-TH-87) SELF-DAMPING MECHANISM FOR APPROXIMATE N/D EQUATIONS. Cornille, H. (Paris Univ., Orsay (France). Institut de Physique Nucleaire). May 1967. 29p. Dep.

Nonrelativistic S-wave N/D equations are considered and the solutions corresponding to the left hand cut discontinuity replaced by an arbitrary but finite number of poles are studied. In the residues of the poles space the interactions are distinguished following the rule that the corresponding states satisfy or not the usual requirement of spectrum in the physical sheet. In this residues space the self-damping domain of physically available interactions is a connected domain and the boundary is the internal Fredholm surface of the N/D equations when the normalization of D is 1 at infinity. (auth)

37933 KOHN VARIATIONAL PRINCIPLE FOR THREE-PARTICLE SCATTERING. Nuttall, J. (Texas A and M Univ., College Station). Phys. Rev. Lett., 19: 473-6(Aug. 21, 1967).

The Kohn variational principle is extended to apply to scattering processes where a two-particle bound state is broken up by a third particle. (auth)

37934 SOLUTIONS OF THE EXTENDED LEE MODEL WITH THE INTERACTION OF $W \rightleftharpoons V\theta$. Chen, Fei S. (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 159: 1278-82(July 25, 1967).

The Lee model is extended to include an additional field W with the higher-order interaction $W \rightleftharpoons V + \theta$. By using Green's-function techniques, the $V\theta$ and $N\theta$ scattering amplitude can be obtained exactly. The model could be applied to studying the distinction between three-particle resonances and two two-particle resonances, if the former were to occur in an energy region in which A and B and A and C are simultaneously resonating. Introducing a resonance V^* in the $N\theta$ channel, the model contains two elementary V fields, one W field, one N field, and the θ field. Scattering amplitudes of both $V\theta$ elastic and production processes are obtained in analytic form. It is possible to obtain on- and off-mass-shell solutions for them. Various properties of the amplitudes are discussed. (auth)

37935 SUPERCONVERGENCE RELATIONS FROM REGGE-POLE THEORY. Schwarz, John H. (Princeton Univ., N. J.). Phys. Rev., 159: 1269-71(July 25, 1967).

A class of approximate superconvergence relations are obtained, which should be valid to the extent that effects of a "third" double spectral function are negligible. (auth)

37936 BRANCH POINTS, FIXED POLES, AND FALLING TRAJECTORIES IN THE COMPLEX J PLANE. Jones, C. Edward; Teplitz, Vigdor L. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 159: 1271-7 (July 25, 1967). (MIT-2098-298).

By means of the N/D equations, analytically continued in complex angular momentum, the details of the mechanism by which cuts in the angular-momentum plane eliminate Gribov-Pomeranchuk singularities are considered. The implications of the two-body unitarity requirement are investigated. A fixed l-plane pole in the signatured partial-wave amplitude is shown to exist where the first Gribov-Pomeranchuk singularity would be expected in the absence of cuts. It is also shown in this case that moving (Regge) poles are not asymptotic to the position of the fixed pole. (auth)

37937 STUDY OF BRANCH POINTS IN THE ANGULAR-MOMENTUM PLANE. Rothe, Heinz J. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 159: 1471-87(July 25, 1967). (UCRL-17068(Rev.)).

A study is made of the Amati-Fubini-Stanghellini (AFS) type of approximation to the amplitudes associated with the exchange of a single Regge pole and an elementary spinless particle, and with the exchange of two Regge poles. The location, motion, and nature of the singularities in the complex-angular-momentum plane of the s reaction which appear in these approximations, and their cancellation in the full diagram, are considered in detail; the singularities are found to be of two general types: branch points whose positions are independent of, and dependent on, particle masses. Only the former singularities determine the asymptotic behavior of the AFS amplitudes in the physical scattering region, while the latter appear only on the physical sheet via the mass-independent branch points at unphysical momentum transfers. The same method used in the study of the AFS approximation to the diagrams which do not have the AFS-type singularities is applied to the analysis of the Mandelstam diagrams for which the above-mentioned cancellation of the cuts does not occur; the analysis, although less rigorous, suggests that the location and nature of the singularities in the j plane are the same as those found for the AFS type of approximations to the simpler versions of these diagrams. With a number of approximations which, although plausible, are hard to justify rigorously, an estimate is made of the contribution to the amplitude coming from the angular-momentum cut. (auth)

37938 REGGE-POLE THEORY AND SPIN INDEPENDENCE OF THE TOTAL CROSS SECTIONS. Lin, Keh Ying (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 159: 1363-5(July 25, 1967).

The general conditions under which the total cross sections are independent of spin are discussed. It is shown that the forward elastic scattering matrix is proportional to the unit matrix in the helicity space if and only if the crossed channels either do not flip helicities, or do not flip helicities more than 1 and have the quantum number $P = (-1)^J$. This theorem follows directly from the Trueman-Wick crossing relations. In particular, the theorem implies that the total cross sections are spin-independent at the

high-energy limit if the forward elastic-scattering amplitudes are dominated by the Pomeranchuk trajectory. (auth)

37939 DISPERSION RELATIONS FOR THREE-PARTICLE SCATTERING AMPLITUDES. II. Rubin, Morton (Univ. of Wisconsin, Madison); Sugar, Robert; Tiktopoulos, George. Phys. Rev., 159: 1348-62(July 25, 1967).

A discussion of the scattering of three nonrelativistic spinless particles interacting via two-body Yukawa potentials is continued. The on-energy-shell T matrix is studied as a function of the total center-of-mass energy E for fixed physical values of the vectors $y_i = k_i(2m_iE)^{-\frac{1}{2}}$, $y_i' = k_i'(2m_iE)^{-\frac{1}{2}}$, i = 1, 2, 3. Here k_i and k_i' are the initial and final momenta of the particles, respectively, and m_i are the masses. It is shown that T(E) can be written as the ratio of two Fredholm series, each of which is uniformly convergent with respect to E for all values of E on the physical sheet including the real axis. Since it was previously seen that each term in these series satisfies a dispersion relation in E with no complex singularities, it follows that the full three-particle amplitude satisfies such a dispersion relation. (auth)

37940 THRESHOLD BEHAVIOUR OF PARTIAL WAVES AND THE CDD AMBIGUITY. Stihi, M.; Visinescu, M. (Inst. for Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 515-23(1967).

Integral equations for the generalized Jost function corresponding to partial waves with $l > 0$ are studied in the case of the one-channel elastic scattering. Restrictions imposed by the threshold behavior on the solution with CDD poles are obtained. (auth)

37941 ASYMPTOTIC BEHAVIOR OF THE ELASTIC SCATTERING AMPLITUDE AND THE RATIO OF THE REAL AND IMAGINARY PARTS. Vernov, Yu. S. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 53: 191-202(July 1967). (In Russian).

Inequalities which improve the Froissart restriction are obtained for the asymptotic and not completely imaginary amplitude f (E). Under some weak assumptions it follows from them that Re f (E) < 0 asymptotically. The relation between the total cross section σ (E) and the ratio ξ (E) of the imaginary to the real parts of the amplitude, which was previously established with a power accuracy, is extended to factors which slowly vary with the energy. It is shown that the cross section becomes constant if $|\xi(E)| > (\ln E)^{l+1}$. The relation between the phase and the elastic scattering amplitude module is considered for arbitrary transferred momenta. (auth)

37942 APPROACH TO CURRENTS AND THE DERIVATION OF CURRENT ALGEBRA. Taha, M. O. (Cambridge Univ., Eng.). Phys. Rev., 158: 1623-9(June 25, 1967).

The integral representation of second-order current elements in terms of first-order current operators is obtained on the basis of unitarity, analyticity crossing, and an assumption on high-energy behavior. A corresponding representation is then obtained for S-matrix elements which is similar to that of the Lehmann–Symanzik–Zimmermann formulation of field theory. It is shown that the once-integrated first-order currents close under equal-time commutation. (auth)

37943 WARD IDENTITIES, UNSUBTRACTED DISPERSION RELATIONS, AND FEYNMAN GRAPHS. Bardakci, K.; Halpern, M. B.; Segre, G. (Univ. of California, Berkeley). Phys. Rev., 158: 1544-57(June 25, 1967).

The interplay of commutators involving a conserved current, Feynman graphs, and dispersion relations are studied in an attempt to formulate general rules for when the invariants involved in the decomposition of matrix elements of retarded products of currents obey unsubtracted dispersion relations. The main conclusions are two: (1) The assumption of unsubtracted dispersion relations is incorrect when one of the currents is conserved and the other is the source of a strongly interacting particle on its mass shell. (2) When one current is conserved and the other is the source of a system which interacts only weakly or electromagnetically, the assumption may be correct to lowest order in the nonstrong interactions. These relations are, however, on a much different and less firm footing than the sum rules using the hypothesis of partially conserved axial-vector current (like that of Adler and Weisberger). In particular, assuming the unsubtracted dispersion relations, it is found that the result (e.g., the sum rules of Cabibbo and Radicati) has a structure such that, to all orders in any field theory, the $N^*(\omega)$ intermediate-state graphs project to zero, that is, they fail to contribute to the charge radius of the nucleon (pion), whereas, calculated dispersively, they do contribute. It is also shown that the real part of amplitudes of type (2) has a fixed power behavior in energy. (auth)

37944 COVARIANCE AND THE CANCELLATION OF SCHWINGER AND SEAGULL TERMS IN APPLICATIONS OF CURRENT ALGEBRAS. Brown, Stanley G. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 158: 1444-7(June 25, 1967).

Manifest covariance and the assumption that the equal-time commutators (ETC) of currents and spatial components of fields are no more singular than delta functions are shown to imply the cancellation of Schwinger and seagull terms in the divergence of the scattering amplitude. Slightly stronger assumptions about the field-current ETC used in previous work are shown to imply the more specific Schwinger-seagull relations found there, without the need of divergence conditions. The technique used is generally applicable to the study of the relation of Schwinger and seagull terms. The role of divergence conditions in previous work is discussed. (auth)

37945 COHERENCE IN THREE-BODY FINAL STATES. Amado, R. D. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 158: 1414-21(June 25, 1967).

The amplitude for a reaction leading to three free particles is studied in the context of nonrelativistic scattering theory with particular emphasis on the distribution of information about final-state interactions of a given pair. It is shown that contrary to the simple notions often read into the Faddeev equations, terms ending with the interaction of a given pair do not carry the major information about interactions of that pair. When a coherent combination of all terms contributing to the process is taken, a factor clearly carrying the features of a pair's final-state interactions appears multiplying the entire amplitude. This factor carries the elastic-scattering phase of the pair. It will dominate the variation of the amplitude with respect to final-state interactions of the pair if certain other terms vary slowly, and this seems plausible. Application of this result to triangle singularities shows that the coherent combination of terms with and without final rescattering changes the singularity qualitatively. The assignment of a final-state interaction factor onto the entire amplitude for each pair suggests a product-type final-state wave function for the process. The implications of this for overlapping resonances are discussed with particular reference to static models and the absence of the Peierls mechanism. The case of two particles interacting independently with a fixed center, for which the product wave function is exact, is discussed from the Faddeev viewpoint and shows that a multiple-scattering approach can be misleading. (auth)

37946 KINEMATIC CONSTRAINTS, CROSSING, AND THE REGGEIZATION OF SCATTERING AMPLITUDES. Abers, Ernest (Univ. of California, Los Angeles); Teplitz, Vigdor L. Phys. Rev., 158: 1365-76(June 25, 1967).

An investigation is made of the constraints among helicity amplitudes which hold at the boundary of the crossed-channel physical region, like the one discovered for nucleon-nucleon scattering by Goldberger, Grisaru, MacDowell, and Wong, and a general scheme is developed for computing these rules with arbitrary external spins. For equal-mass elastic scattering these constraints hold at $s = 0$; a catalog of them for several low-spin cases is presented. Complete knowledge of these conditions is needed to discuss, for a general scattering amplitude, a question first raised by Gell-Mann et al. in connection with electrodynamics, namely, under what conditions must be a given expression for an S matrix (e.g., the perturbation expansion of a field theory) be analytic in the angular momentum? Mandelstam has argued that this "Reggeization" of the vector-spinor amplitude is a consequence of kinematic constraints, and hence independent of the perturbation expansion. He discussed only the equal-mass, $j = \frac{1}{2}$ case. His argument is generalized to unequal masses and to arbitrary spins and angular momenta, and discuss, case by case, the necessity of Reggeization of a list of low-spin amplitudes. It is found in particular that under rather general assumptions a spin-$\frac{1}{2}$ particle must lie on a Regge trajectory in a large class of amplitudes, and that the π^+p amplitude is analytic in j in perturbation theory. (auth)

37947 PROJECTION OPERATORS IN THE THEORY OF REACTIONS. Sasakawa, Tatuya (Tohoku Univ., Sendai). Phys. Rev., 158: 1249-54(June 25, 1967).

In the asymptotic limit, the total wave function of a many-particle system should contain all possible open and closed channels of all available multiclusters. It is demonstrated that the total wave function which is fully connected shows this asymptotic behavior. (auth)

37948 SOME REMARKS ON THE LOCATION OF SINGULARITIES IN S-MATRIX THEORY. Jacobson, D. A. (Douglas Advanced Research Labs., Huntington Beach, Calif.). Nuovo Cim. (10), 50A: 646-56(Aug. 1, 1967).

It is shown that the standard procedure for locating singularities in S-matrix theory through the analytic continuation of the unitarity relation (making use of the crossing relations and Hermitian analyticity), is not sufficient to determine upon which Riemann sheet

certain "nonintersecting" singularities lie. The ambiguity is removed by assuming all such nonintersecting singularities absent from the physical sheet. Arguments are given which suggest that this assumption may be sufficient to "complete" the proofs of Hermitian analyticity and the crossing relations. Finally, it is shown that the assumption follows from a physical-sheet postulate which represents a strengthening of the usual $i\epsilon$-prescription. (auth)

37949 EXACT SOLUTIONS OF A GENERALIZED TWO-CHANNEL STATIC MODEL. Cunningham, A. A. (Univ. of Adelaide). Nuovo Cim. (10), 50A: 535-44(Aug. 1, 1967).

The two-channel static model with wholly generalized crossing symmetry is solved generally by means of the Rothleitner transformation of the energy plane. The phase shifts are computed for a class of crossing matrices dependent on one continuous parameter, corresponding to an SU_n symmetry for integral values. The possibility of imposing a bootstrap requirement on the solutions is also considered, but little restriction in the arbitrariness of the solutions appears possible. (auth)

37950 VERTEX FUNCTIONS IN THE DISPERSION THEORY OF CURRENT ALGEBRAS. Renner, B. (Cambridge Univ., Eng.). Nuovo Cim. (10), 50A: 605-16(Aug. 1, 1967).

Vertex functions are investigated in the dispersion theory of current algebras. The cases considered constitute a particularly simple opportunity to study the mutual consistency of the various assumptions usually used. It is demonstrated that the assumption of unsubtracted dispersion relations for integrals over matrix elements of current commutators leads to contradictions, when applied to all invariants in the kinematic decomposition of the tensors. These difficulties can be avoided only if one accepts operators of isospin one in Schwinger terms. The same contradictions are found, if in the infinite-momentum approach one admits commutators of current time and space components. The equivalence of the two approaches depends on the validity of superconvergence relations for the asymptotic behavior of some form factors. (auth)

37951 RASSEYANIE, REAKTSII I RASPADY V NERELYATIVISTSKOI KVANTOVOI MEKHANIKE. (Scattering, Reactions, and Disintegration in Nonrelativistic Quantum Mechanics). Baz, A. I.; Zel'dovich, Ya. B.; Perelomov, A. M. Moscow, Izdatel'stvo Nauka, 1966. 339p.

The theory of scattering, S-matrix, and continuous spectrum analyses are discussed. The peculiarities of scattering amplitudes during uncovering of new channels, the theory of unstable particles, the existence of intermediate scattering states, and the new formulation of the Lee model are also discussed as well as the production of particles, nonconservation of parity and the nonrelativistic theory. Two hundred and forty-five references are included. (R.V.J.)

Particle Accelerators

Refer also to abstracts 36223 and 36372.

37952 (AERE-M-1553) THE BRAZING OF THE ORBIT COIL OF THE HARWELL VARIABLE ENERGY CYCLOTRON. Purchas, J. G. (Atomic Energy Research Establishment, Harwell (England)). May 1965. 17p. Dep.

Creep cavitation was shown to be a cause of cracking in the copper conductors of the orbit coil when it is subjected to a brazing cycle in which the components were maintained at temperatures above 750°C for long periods. Investigations which were carried out to select an alternative low temperature brazing alloy with adequate strength are described. Silfos was shown to be a suitable alloy and two complete assemblies were successfully brazed. (auth)

37953 (BMwF-FBK-67-58) MESSUNG VON ZEITLICHEM VERLAUF UND MITTELWERT DES STRAHLSTROMES EINES LINEARBESCHLEUNIGERS MIT HILFE EINER INDUKTIONSSPULE. (The Measurement of the Time Dependent Waveform and the Average Beam Current of a Linear Accelerator by a Magnetic Pickup Coil). Mehlig, D. (Max-Planck-Institut fuer Chemie, Mainz (West Germany)). June 1967. 14p. (In German). Dep.

The beam current of a linear accelerator is measured by a magnetic pickup coil. A reliable electronic circuit permits the observation of the time dependent waveform and the charge for each single linac beam pulse on a scope as well as the measurement of the total charge during a run. The accuracy is better than 1% for a pulse length between 0.2 to 3.3 μsec and for pulse currents from 20 to 400 mA. (auth)

37954 (BNL-11614) EFFECTS OF SEXTUPOLES NEAR A ONE-THIRD INTEGRAL ν VALUE IN THE AGS: THEORY. Month, M. (Brookhaven National Lab., Upton, N. Y.). July 7, 1967. 24p. Dep. CFSTI.

The effects of sextupole perturbations in the AGS near a one-third integral ν value are calculated. The method consists of separating the linear and nonlinear systems and treating the nonlinear part as a perturbation, and also treating that part of the linear matrix which deviates from a $\frac{1}{3}$ integral ν value as a perturbation of the same order as the sextupole strength. (R.C.M.)

37955 (BNL-11620) COMBUSTIBLE GAS DETECTION IN HIGH-ENERGY RESEARCH OPERATIONS. Baker, Leonard A. Jr.; Ferraro, Carlo Jr. (Brookhaven National Lab., Upton, N. Y.). [1967]. 12p. (CONF-670903-9). Dep. CFSTI.

From 22nd Instrument-Automation Conference and Exhibit, Chicago, Ill.

A description of the high energy research uses of liquid hydrogen, with attendant safety problems, and current practices in coping with these problems is given. The instruments utilized to detect accidental leaks of hydrogen are described. Included is the background for the changes made on gas detection systems installed at Brookhaven National Laboratory and comparisons are made of the various system types in use. Current test practices and maintenance experience with combustible gas detection systems are also outlined. (auth)

37956 (BNL-11631) MEASUREMENT OF THE SHIFT IN FREQUENCY OF THE COHERENT VERTICAL BETATRON OSCILLATIONS AT INJECTION AS A FUNCTION OF BEAM CURRENT IN THE AGS. Raka, E. C. (Brookhaven National Lab., Upton, N. Y.). July 18, 1967. 5p. Dep. CFSTI.

When a circulating synchrotron beam executes coherent betatron oscillations, image forces arising from fields induced by the beam in the vacuum chamber and magnet poles can alter the oscillation frequency. This frequency shift is usually negative and for small $\Delta\nu$ and large ν it is directly proportional to the number of particles present. A method for determining $\Delta\nu$ is outlined. (C.E.S.)

37957 (CEAL-1036) SEMI-ANNUAL REPORT FOR THE PERIOD JULY 1-DECEMBER 31, 1966. (Cambridge Electron Accelerator, Mass. Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2076. 31p. Dep. CFSTI.

Part I indicates the purpose of the work, which is concerned with the operation of the 6-GeV Cambridge Electron Accelerator. Part II states the general nature of each of the 38 experiments that were in progress or in preparation during the six-month period in question. Part III lists the principal improvements made in the accelerator and the associated facilities. Part IV deals with the routine operation of the accelerator, and indicates that the half-year in question was far more productive, in terms of user-hours, than any previous half-year period. Part V deals with safety, and indicates that there were no lost-time accidents. Part VI summarizes the plan for using the present ring as a beam storage and colliding beam facility; also it describes new tests and demonstrations of beam storage, including the storing of 3 GeV electrons for 20 minutes, a new world's record. This project continues to appear highly promising. Part VII deals with preparations for the sixth International Conference on High Energy Accelerators, to be held in Cambridge on September 11-15, 1967. (auth)

37958 (FTI-102/T-035) VLIYANIE PERIODICHESKIKH I SLUCHAINYKH VOZMYSHCHENII NA NELINEINYE SISTEMY. (Effect of Periodic and Random Perturbations on Non-Linear Systems). Bakai, A. S. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1966. 89p. (In Russian). Dep.

Phenomena due to nonlinearity, however small the nonlinearity is, are qualitatively different from phenomena in linear systems. Methods of solving nonlinear equations, which were developed by Puankare, Lyapunov, Krylov-Bogolyubov, and others are reviewed. Most of these methods involve a series containing a slowly changing variable. For example, a typical example involves the effect of a sinusoidal force with a slowly varying frequency and amplitude on a nonlinear oscillator. The phase behavior and the position of particular points on the phase surface are given. The effect of an applied sinusoidal force on a nonlinear oscillator is also considered in the presence of random perturbations. Resonance in a nonlinear system in the presence of random impulses, spectral density, average half-life of particles in an accumulator, leakage of particles from an accumulator due to the quantum nature of the radiation or due to instability of amplitude and frequency of the compensating field, and stabilization of systems with nonlinear friction are types of problems that are solved by nonlinear mathematical methods. (TTT)

37959 (JINR-P9-3393) SRAVNENIE RADIAL'NOGO PROFILYA POLYA IZLUCHENIYA VOKRUG USKORITELEI PROTO-

NOV OIYAI. (Comparison of a Radial Shape of the Radiation Field Around the JINR Proton Accelerators). Aleinikov, V. E.; Lebedev, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 11p. (In Russian). Dep.

The results are given of measurement of the flux density distribution and the dose equivalent of <20-MeV neutrons around the proton accelerators of the JINR. The results of measurements are compared to the data obtained from the other high-energy proton accelerators. The empirical formulas for calculation of flux density and neutron dose equivalent are given. (auth)

37960 (JINR-P9-3403) IZMERENIE SPEKTRA RASSEYANNYKH NEITRONOV V POMESHCHENII SINKHROTSIKLOTRONA. (Measurements of the Spectra of Stray Neutrons at Synchrocyclotron Hall). Kimel, L. R.; Komochkov, M. M.; Sidorin, V. P.; Smirnitskii, V. N.; Sychev, B. S. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1967. 7p. (In Russian). Dep.

The energy spectra of stray neutrons are determined with the aid of nuclear emulsions K-600 at different places of the main JINR synchrocyclotron hall. (auth)

37961 (JINR-P9-3435) OSLABLENIE RASSEYANNOGO IZLUCHENIYA SINKHROTSIKLOTRONA V ZASHCHITE. (Attenuation of Synchrocyclotron Stray Radiation in Shielding). Zaitsev, L. N.; Kimel, L. R.; Komochkov, M. M.; Sidorin, V. P.; Sychev, B. S.; Ulitin, O. A.; Cherevatenko, E. P. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1967. 11p. (In Russian). Dep.

The attenuation of synchrocyclotron stray radiation in ordinary and heavy concrete is experimentally investigated. The data obtained allow to check the calculation method of the formation and attenuation of stray radiation in the shielding and to approach a question of the shielding construction more substantially. (auth)

37962 (MSUCP-22) MAGNETIC FIELD MEASUREMENTS FOR THE MSU CYCLOTRON. Berg, R. E.; Blosser, H. G.; Johnson, W. P. (Michigan State Univ., East Lansing. Cyclotron Project). Aug. 1966. 56p.

The results of an extensive series of magnetic field measurements performed on a full scale magnet, including effects of trimming coils, are presented. Field data were taken on the main magnet field (without trimming coils) at seven excitations, individually on each of eight pairs of circular trimming coils at four main field excitations, and on one set of first harmonic coils at two main field excitations. (B.G.D.)

37963 (MSUCP-23) PHASE SPACE DENSITY STUDIES ON CYCLOTRON ION SOURCES. Mallory, Merrit Lee (Michigan State Univ., East Lansing. Cyclotron Project). June 1966. 79p. Thesis.

A facility has been set up for development and testing of cyclotron ion sources with special emphasis on capability for rapid phase space density measurements. H^+ ions from the test source are accelerated into a – 30 kV dc dee and magnetically deflected through 180°. A system of remotely adjustable slits is mounted inside the dee and is used to determine the axial and radial emittance areas. The phase space density was determined from the axial and radial emittance area measurements at a variety of arc conditions and for a number of source geometries. All studies employed a 0.062" × 0.375" source output slit with arc currents varied from 1 to 5 amps. Geometrical variations were principally concerned with source face shapes. Both axial and radial emittance areas from a normal flat source are found to have a considerable admixture of coherent motion which results in inefficient use of the aperture and also, in combination with nonlinear fields, can lead to an effective dilution of the phase space density. Moderate recessing of the source contributes a focusing force in both r and z and makes the phase space volume much more compact. The effects of plasma boundary and space charge are evidenced in the axial measurements. The axial plasma boundary is found to be concave, with the result that ions emitted from the top and bottom of the ion source slit focus toward the median plane. Space charge effects are clearly discernible; the axial width of the beam linearly increases as a function of total beam current. In the radial emittance area measurements, an asymmetry in the radial position of maximum current was found and traced to a shifting plasma boundary. This shift was subsequently shown to be the result of a strain displacement of the ion source filament. (auth)

37964 (MSUCP-24) PRECISE METHODS FOR PRECALCULATION OF CYCLOTRON CONTROL SETTINGS. Berg, Richard Eugene (Michigan State Univ., East Lansing. Cyclotron Project). Sept. 1966. 122p.

Thesis.

A computer program, SETOP, was written which uses measured magnetic fields and a pre-computed set of ideal average fields to determine operating points for the MSU variable-energy, multi-particle cyclotron; to obtain a complete set of operating instructions, the experimenter need only specify the particle and energy of interest. Control settings are computed in a straightforward sequence of operations: the fields at the desired excitation are synthesized by interpolation in the measured field data, an average field is obtained using a modified least squares fit of the desired average field by the trim coils, and the rf frequency is determined so as to minimize the energy spread of the beam in a single turn at the extraction energy. Independent numerical orbit studies were employed to investigate important features of the separated longitudinal equations of motion as used in SETOP, and several diagnostic procedures were investigated using numerical orbit integration to establish their validity under conditions obtained in the MSU cyclotron. Finally, the results of experimental measurements of several dynamical beam properties are presented which are in excellent agreement with pre-computed values. (auth)

37965 (RHEL/R-148) NIMROD OPERATION AND DEVELOPMENT. Quarterly Report, January 1–March 31, 1967. Gray, D. E. (ed.) (Rutherford High Energy Lab., Chilton (England)). June 1967. 13p. Dep. CFSTI. UK 2s. 6d.

Operation of the accelerator and the experimental work in progress are described. The performance of the plunging mechanisms associated with the extraction system was improved significantly. The 80 cm liquid helium bubble chamber was commissioned, and re-installation of the 1.5m British National Hydrogen Bubble Chamber was completed. Installation of the X1/X2 extracted proton beam line is in progress. (UK)

37966 (UCRL-17641) RECORDING, ANALYZING, AND REPRESENTING LARGE-SCALE DIGITAL MEASUREMENTS OF MAGNETIC FIELD. Nelson, Donald H. (California Univ., Berkeley. Lawrence Radiation Lab.). June 29, 1967. Contract W-7405-eng-48. 8p. (CONF-670705-10). Dep. CFSTI.

From 2nd International Conference on Magnet Technology, Oxford, England.

The continuous demand for large-scale high-precision magnetic field measurements at Lawrence Radiation Laboratory has resulted in the development of streamlined data-handling procedures and data-processing programs. These procedures and computer programs have been developed during the course of processing about 5,000,000 magnetic field measurements in the past four years. Techniques are presented which are valid regardless of the data-acquisition system employed. However, examples are drawn from experience with the Lawrence Radiation Laboratory Rapid Mapper Magnet-Measuring system, which has been successful largely because it was designed with these techniques in mind. The Rapid Mapper's standard recording sequences and computer programs for detecting and correcting errors, normalizing the data, comparing sets of data, and producing graphs and contour plots are described. (auth)

37967 (UUIP-536) PROPERTIES OF AN ALTERNATING DIRECTION IMPLICIT METHOD IN THE CALCULATION OF A MAGNETIC FIELD FROM A MEASURED BOUNDARY. Groth, T.; Olsen, B.; Pettersson, G. (Uppsala Univ. (Sweden). Inst. of Physics). 1967. 23p. Dep.

An alternating direction implicit (ADI) method was applied to the problem of calculating the components of a magnetic field in a grid, when values of the components are given on the boundary. The calculations were applied to the axially symmetric case of a long-lens spectrometer. The procedure may be extended to a multidimensional case. The influence of two kinds of errors were investigated. The ADI method turns out to be useful as soon as an accurate determination of a magnetic field in a region is of interest, e.g., for cyclotron calculations and investigations of different types of magnetic lenses. (auth) (Sweden)

37968 RADIOACTIVE GAS PRODUCTION AT A 100-MeV ELECTRON LINAC FACILITY. Kase, Kenneth R. (Univ. of California, Livermore). Contract W-7405-eng-48. Health Phys., 13: 869-76(Aug. 1967). (UCRL-14662).

A method is presented for determining the production of radioactive ^{13}N and ^{15}O at a 100-MeV electron linear accelerator facility. The dependence of the air concentrations of these nuclides on ventilation rates and beam travel distance is discussed. It is determined that ^{13}N is the limiting radionuclide; MPC and dose calculations are presented for this nuclide. The implications of ^{13}N production are discussed in terms of ventilation rates for target areas and operational controls. A sample calculation is presented. (auth) (UK)

37969 MODULATED NEUTRON SOURCE. Foley, John E. Seale, Robert L. (Univ. of Arizona, Tucson). Trans. Amer. Nucl. Soc., 10: 313-14(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37970 A SIMPLE METHOD FOR DETERMINING THE ENERGY AND CURRENT OF AN ACCELERATOR ELECTRON BEAM. Motz, J. W.; Sparrow, J. H. (National Bureau of Standards, Washington, D. C.). Trans. Amer. Nucl. Soc., 10: 90-1(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37971 PHOTON ACTIVATION TARGET ASSEMBLY FOR THE NBS LINEAR ELECTRON ACCELERATOR. Lundgren, F. A.; Lutz, G. J. (National Bureau of Standards, Washington, D. C.). Trans. Amer. Nucl. Soc., 10: 89-90(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

37972 BEAM MODULATING SYSTEM FOR THE CYCLOTRON. Moteca, P.; Andruscenco, P.; Ivanov, E.; Macovei, M.; Papureanu, S.; Stancu, V. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 479-85(1967).

A system for the modulation of the accelerated ion beam of the cyclotron is described. This is achieved by means of an electrode placed between the ion source slit and the extracting Dee. The system was in operation for about 200 hours and was able to deliver a pulsed beam current, with a pulse-width down to 5 μsec. (auth)

37973 ELEMENTARY-PARTICLE EXPERIMENTS WITH AN ELECTRON SYNCHROTRON (THE SITUATION IN JAPAN). Takeda, Gyo (Tohoku Univ., Sendai). Nippon Butsuri Gakkaishi (Buturi), 21: 619-25(Sept. 1966). (In Japanese).

The electron synchrotron at the Institute for Nuclear Study was initially operated at maximum 750 MeV, then it was gradually improved to give finally several 10^9 electrons per pulse. During this period of about three years the first-round experiments were carried out by the respective research groups, and at present the results are being arranged. These results of experiments obtained with the synchrotron are described. A review is first made of the following as the structure of nuclear particles, clarified by the experiments in oversea countries: existence and nature of the nuclear particle excited state; electric and magnetic multipole moments of nuclear particles; and charge and magnetic moment distributions of nuclear particles. The experiments with the electron synchrotron were aimed at obtaining more qualitative information on the various reactions in the N^* region, carrying out experiments at the energies and angles not tackled yet in oversea countries, and making the initial measurements of small-cross-section reactions. Thus, reporting on the experiments performed in the N^* region, the following are described: Compton scattering, deviation of recoil protons in the production of π^0, formation of two mesons, and formation of π^0 by deuterons. Finally, a discussion is made on the relation between the various multipole moments obtained by the experiments on the γ-π and γ-2π reactions, and in the theoretical values in the SU(6) symmetry theory. (NSA of Japan)

37974 HYDROCARBON PROTON POLARIZED TARGET. Moretti, A.; Yokosawa, A.; Markley, F. W.; Miller, R. C. (Argonne National Lab., Ill.). Rev. Sci. Instrum., 38: 1335-6(Sept. 1967).

A study was made of proton polarization in hydrocarbons doped with DPPH, Galvinoxyl, and ditertiary butyl nitroxide (DTBN). The samples for the study were prepared either by dissolving the free radical directly in the solute or by dissolving both the radical and final solute in an intermediate solvent. A summary of the measurements in toluene, polystyrene, Lucite, and polyethylene is presented. A polarization of 28% was achieved in Parowax doped with DTBN, which is concluded to be the highest measured polarization in a CH_2 type material and possibly useful as a polarized proton target. (L.B.S.)

37975 MAGNETIC SLIT. Brechna, H.; Cobb, J. (Stanford, Univ., Calif.). Rev. Sci. Instrum., 38: 1289-1301(Sept. 1967). (SLAC-PUB-294).

A magnetic slit for momentum definition and beam separation is described. The 2.5-m magnetic slit was designed and built at the Stanford Linear Accelerator Center to be used in combination with a pulsed bending magnet to guide a 20-GeV/c electron beam with a dispersion of 3% to three experimental areas. (auth)

37976 FOCUSING PROPERTIES OF MAGNETIC LAMINAS AND THEIR APPLICATIONS TO THE MICROTRON. Campolattaro, A. (Princeton Univ., N. J.); Porreca, F. Contract AT(30-1)-2137. Rev. Sci. Instrum., 38: 1322-6(Sept. 1967). (PPAD-518-E).

The possibility of attaining vertical focusing in small accelerating machines, like the microtron, without destroying their marked simplicity, is pointed out. Indeed, it is shown that a vertical focusing in low energy accelerators can be obtained by the location of a magnetic lamina inside and at a suitable distance from the equilibrium orbit. In the case of the microtron, the location of the lamina inside the first orbit and at a distance from the resonant cavity of 0.42 times the radius of this orbit produces a vertical focusing for all orbits. Experiments performed on a 2.5 MeV microtron are in agreement with the theoretical predictions. (auth)

37977 CYLINDRICAL CAPACITOR AS AN ANALYZER I. NONRELATIVISTIC PART. Sar-el, H. Z. (Soreq Nuclear Research Center, Yavne, Israel). Rev. Sci. Instrum., 38: 1210-6(Sept. 1967).

The dynamic and optical properties of the cylindrical capacitor for nonrelativistic charged particles were studied for certain arrangements of the source and some interesting features were found. A point source embedded in the inner cylinder on the common axis of the capacitor can be imaged for any angle of emission θ_0 between 0 and $\pi/2$. Each angle θ_0 has its corresponding K_0 factor incorporating the geometrical and electrical parameters of the device. K_0 and θ_0 together determine uniquely the distance between the source and its image on the common axis of the capacitor. There exists a first order focus for all angles of emission except $\theta_0 = 42°18.5'$; for the latter there is a second order focus. The figures of merit of this analyzer concerning resolution and transmission were found to be better than those of other forms of the cylindrical analyzer. However, the deflecting voltages required in the new device are higher. The calculations were checked experimentally for $\theta_0 = \pi/4$. (auth)

37978 THIN CARBON FILMS FOR TARGET BACKINGS. Kerekatte, S. S.; Sekharan, K. K.; Nambiar, K. B. (Bhabha Atomic Research Centre, Bombay). Indian J. Pure Appl. Phys., 5: 107-8(Mar. 1967).

The preparation of thin carbon films for use as target backings in charged-particle reaction experiments is described. The thickness of a sample film, measured by determining the energy loss of 1.37-MeV alpha particles in the film, was found to be 10 ± 2 $\mu g/cm^2$. The films have high tensile strength, good conductivity, and small Coulomb scattering effects. (auth)

37979 PULSED ELECTRON BEAM VAN DE GRAAFF ACCELERATOR. Sawicki, Aleksander; Orzechowski, Tadeusz; Hentszel, Andrzej; Rzewuski, Henryk; Werner, Zbigniew; Merski, Kazimierz (Inst. of Nuclear Research, Polish Academy of Sciences, Swierk). Nukleonika, 12: 441-50(1967).

The adaptation of the dc electron Van de Graaff accelerator for pulse irradiation realized in the Laboratories II and III of the Institute of Nuclear Research at Swierk is described. The accelerator with the dc beam was put into operation in 1965, and adapted, in 1966, to pulse radiation damage investigation in semiconductors. (auth)

37980 DETUNING EFFECT COMPENSATION IN THE CAVITY RESONATORS OF PARTICLE-ACCELERATING MACHINES. Fabiani, D.; Puglisi, M. (CNEN, Rome). Alta Freq., 36: 46E-137; 51E-145(1967).

Thermal variations and mechanical vibrations can change slightly the geometrical dimensions, and consequently the tuning, of a cavity resonator. It is shown that, with the aid of a suitable negative feedback, it is possible to stabilize, against the effect of small tuning variations, the amplitude and the phase of the voltage developed across the gap of the resonator. This is illustrated with reference to the electron and positron storage ring (Adone) that is now being completed at the National Laboratories of Frascati, the construction and operation of which are described. The geometry of the 4 resonators designed to maintain the particles in orbit is shown, and the circuitry for the correcting system is diagrammed. Among the many control systems that have been so far employed, the one described, that presumably has never been proposed for the r-f equipment of accelerating machines, seems to be superior because only one feedback loop allows practically perfect compensation of the amplitude and phase of the voltage of the cavity. Such a system, based only on phase measurement, is inoperative against the cavity voltage variations that do not depend upon a detuning of the cavity and so allow the regulation of the cavity voltage without any change on the feedback system. (BBB)

37981 EQUIPMENT FOR EJECTION AND CONTROL OF A LOW-ENERGY (lt 600-keV) PROTON BEAM IN AIR. Pucheault, J.; Julien, R.; Chevrel, J. (Laboratoire de Synthese Atomique et d'Optique Protonique, Ivry, France. Laboratoire Curie, Paris). Rev. Phys. Appl., Suppl. J. Phys., 2: 137-42(June 1967). (In French).

An apparatus is described which may be adapted to a proton accelerator for the purpose of obtaining a low-energy beam (E < 600 keV) in air. A thin glass window is employed. A method is outlined for the determination of the intensity of the low-energy beam and its energy on striking the target. (auth)

37982 EXPERIMENTS ON PRODUCTION OF INTENSE PROTON BEAMS BY CHARGE EXCHANGE INJECTION METHOD. Budker, G. I.; Dimov, G. I.; Dudnikov, V. G. At. Energ. (USSR), 22: 348-56(May 1967). (In Russian).

The results of experiments on the accumulation of protons in an orbit with constant magnetic field by the charge exchange method in resonance regime were reported. The coherent effects, connected with the high intensity, were detected and investigated. It was established that the limitation of the orbital current is connected with the effect of the longitudinal component of the electric field of the beam. (tr-auth)

37983 EFFECTIVE METHOD OF DAMPING OF PARTICLE OSCILLATIONS IN PROTON AND ANTIPROTON STORAGE RINGS. Budker, G. I. At. Energ. (USSR), 22: 346-8(May 1967). (In Russian).

A method for the damping of synchrotron and betatron oscillation of heavy particles, using an abrupt increase of the interaction cross section of these particles with electrons at comparatively small velocities, was proposed. It was shown that by this method it is possible to compress strongly the proton and antiproton bunches in the storage ring and also to accomplish repeated accumulation of these particles. (tr-auth)

37984 A NEW DESIGN FOR A COCKCROFT-WALTON VOLTAGE MULTIPLIER USING SILICON DIFFUSED-JUNCTION RECTIFIERS. Broadbent, T. E. (Univ. of Manchester, Eng.). J. Sci. Instrum., 44: 570-1(July 1967).

A Cockcroft–Walton voltage multiplier is described in which silicon diffused-junction rectifiers are used instead of selenium rectifiers. The small physical size of these rectifiers, and the particular manner in which the various components are mounted in the generator, combine to form a convenient and compact design which is an improvement on the conventional design using selenium rectifiers. The novel arrangement of components made possible by the use of silicon rectifiers constitutes the original feature of this generator. (auth) (UK)

37985 SIMPLE BERYLLIUM TARGET FOR THERMAL NEUTRON PRODUCTION. Parker, R. H.; Frazer, R. F. (California Inst. of Tech., Pasadena). Nucl. Instrum. Methods, 53: 330 (1967).

Be targets were prepared as thick as 100 μm for use with a high current ion accelerator. (auth)

37986 PRODUCTION OF THIN SELF-SUPPORTING NICKEL FOILS USING AN ELECTROPLATING METHOD. Arnison, G. T. J. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nucl. Instrum. Methods, 53: 357-8(1967).

A method is described that eliminates the use of a metal mandrel during the plating process and produces pure stress-free nickelfoils. (auth)

37987 U. S. NATIONAL PARTICLE ACCELERATOR CONFERENCE, WASHINGTON, D. C., MARCH 1–3, 1967. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1-1233 (June 1967). (CONF-670307).

Separate abstracts are prepared for 161 of 219 papers presented. Fifty-eight were previously included in NSA. For abstract numbers of these papers see CONF-670307 in the report number index. (B.G.D.)

For abstracts of individual papers see: 36441, 36442, 37867, and 37988–38145.

37988 RECENT ADVANCES IN DC ACCELERATORS. Rose, P. H. (High Voltage Engineering Corp., Burlington, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 16-22(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

Recent advances in the use of tandem Van de Graaff accelerators for acceleration of heavy ions are discussed. Topics include multiple stripping, foil strippers, acceleration of iodine and uranium ions, and series arrangement of tandem accelerators. (B.G.D.)

37989 DECADE OF PROGRESS IN CYCLOTRONS: FREQUENCY-MODULATED AND ISOCHRONOUS. Khoe, T. K.; Livingood, J. J. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 23-8(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

The advent of the isochronous cyclotron, capable of accelerating a wide selection of particles with energies variable up to limits previously inaccessible, has spurred the development of techniques leading to increased knowledge of orbit behavior and hence to external beams of greatly bettered quality. Among these activities are improved methods of magnet design, of field control and of beam diagnostics, novel means of launching the projectiles and more effective extraction schemes. Increased versatility has engendered new obstacles; e.g., space charge and charge exchange problems in the use of heavy ions. Advances in synchrocyclotrons, though still largely in the planning stage, reflect the present state of the art of spiral orbit machines. Increased current is the major goal. A variety of schemes for better axial focusing and higher repetition rate are under consideration. Beam stretching and improved focusing by grids or by einzel-type lenses have already been achieved. (auth)

37990 STUDIES OF AN EXPANDED PLASMA FRONT DUOPLASMATRON ION SOURCE. Fasolo, J. A. (Midwestern Universities Research Association, Stoughton, Wis.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 39-45 (June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

A new and more flexible ion source assembly has been built for continued study of a duoplasmatron with an expanded plasma front and a cylindrical Pierce-electrode extraction geometry. Studies of conditions necessary for the formation of an expanded plane plasma boundary are discussed, and progress toward the achievement of an aberration-free parallel beam of several hundred mA of protons is reviewed. Recent studies suggest that a duoplasmatron with an expanded plasma front and a diverging Pierce-electrode extraction geometry would produce significantly higher aberration-free beam currents than can be obtained with the present cylindrical geometry. The information necessary for the design of lens optics for matching such a source, or any source which produces a diverging aberration-free beam, to an accelerator or plasma containment device is provided in a convenient and comprehensive form by beam characteristic curves which give beam radius and divergence as functions of perveance at some convenient measuring plane close to the extractor for several fixed values of arc current. Data provided by a constant perveance experiment establish practical limits on obtainable beam current at the chosen design points on the characteristic curves. (auth)

37991 STUDY OF A DUOPLASMATRON ION SOURCE WITH AN EXPANSION CUP. Abdelaziz, Mohamed E.; Ghander, Ahmed M. (Atomic Energy Establishment, Cairo). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 46-52 (June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

A study is described of a duoplasmatron ion source for the purpose of investigating the conditions necessary to improve its performance. First a general review is made of theoretical considerations involved in the source's plasma mechanism and the geometry of the extraction system. Then the experimental work deals with the arc discharge characteristics as well as the source's performance when the beam is extracted with a simple Pierce extracting electrode. Through an invar anode insert a 70 mA was obtained at 35 kV. The main improvement was then due to beam extraction from an expansion cup which rendered a 300 mA beam at a lower voltage of 18 kV. The use of different anode materials has indicated the influence of magnetic field penetration on plasma focusing within the expansion cup. A beam current reaching 1 ampere was noticed when a non-magnetic anode was used. (auth)

37992 CHARACTERISTICS OF A HIGH CURRENT P. I. G. ION SOURCE AT LOW GAS PRESSURE. Abdelaziz, Mohamed E.; Ghander, Ahmed M. (Atomic Energy Establishment, Cairo). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 53-9(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

The characteristics of a 10 cm P.I.G. (Penning ionization gauge) discharge and its application as an ion source at a low pressure are given. Using a hot cathode two regions of operation are found, one above and the other below 1 micron. Pulsed ion current reaching 1 ampere could be extracted from this source through a 10 cm diameter gridded cathode at a discharge current of about 20 A and a gas pressure of 0.5 micron. The cathode discharge current was found to contain electrons. The ion current to the reflector cathode is about 10% of the discharge current. (auth)

37993 DYNAMAG ION SOURCE WITH OPEN CYLINDRICAL EXTRACTOR. Cleland, M. R.; Kiesling, R. A. (Radiation Dynamics, Inc., Westbury, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 60-4(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

A description is given of a duoplasmatron type ion source which features a novel, open cylindrical extractor electrode, a visible arc chamber and a short-path magnetic circuit. The glass spacer in the arc chamber permits observation of the plasma and

filaments. The short magnetic circuit gives high plasma density at low magnet and arc currents. The open extraction geometry provides high pumping speed to the source and reasonable tolerances for anode alignment. Above a critical value of extraction voltage the ion emission is independent of voltage. At 16 kV, a 5 mA beam of mixed hydrogen ions can be obtained through an 0.008 in. anode aperture. Gas consumption is about 5 atm.-cc/hr. with a conversion efficiency of about 70%. Proton yield is usually better than 50% of the total beam current under these conditions. The emittance (phase space area) is about 3 mrad.-cm. MeV$^{\frac{1}{2}}$ at 1.0 mA. (auth)

37994 SMALL COLD-CATHODE HIGH-INTENSITY CYCLOTRON ION SOURCE. Wells, D. K. (The Cyclotron Corp., Berkeley, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 70-1(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

High beam currents have been achieved with a radial source which fits into the 2-inch gap of a 30-inch cyclotron. The geometry is that of a cold-cathode or P.I.G. source. However, the cathodes are heated to thermionic temperatures by ion bombardment rather than a conventional high-current heated filament. The source is now in use and produces intense beams of H^+, D^+, ^3He, and alpha particles. Internal beams of H^+ or D^+ of more than one mA are obtained routinely at extraction radius. In addition, 30 μA of H^- or D^- are obtained at a stripping foil by merely reversing the magnetic field of the cyclotron. (auth)

37995 PRODUCTION OF NEGATIVE HELIUM IONS BY NEARLY-RESONANT CHARGE EXCHANGE IN POTASSIUM. Ennis, R. M. Jr. (ORTEC Inc., Oak Ridge, Tenn.); Schechter, D. E.; Thoeming, G.; Schlafke, D. B.; Donnally, B. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 75-7 (June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

The design criteria for a source of 5–10μA of He^- ions suitable for tandem accelerator application were investigated. The process used is a nearly-resonant charge exchange between He^+ ions, from a duoplasmatron, and potassium vapor. In the He^+ energy range of 5–25 keV, the He^-/He^+ yield was measured as a function of He^+ energy. Yields of ~2% were observed. A He^- beam emittance of 1.2×10^{-2} cm rad eV$^{\frac{1}{2}}$ was measured. The potassium flux into the system was found to be $\sim 10^{16}$ particles/s. (auth)

37996 MODIFIED He^- ION SOURCE USING Cs VAPOR CHARGE EXCHANGE. Rose, Fred A.; Tollefsrud, P. B.; Richards, H. T. (Univ. of Wisconsin, Madison). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 78-81(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

Earlier versions of the He^- source suffered from cesium metal collecting on insulators and entering the rf source. A single acceleration gap is used to reduce the number of insulators requiring protection and additional shielding of the remaining insulators is provided. The new version also uses a gridded focusing element. Additional baffling and smaller entrance and exit apertures for the exchange canal have eliminated the flow of cesium vapor into the rf source. A further modification to produce higher current adds an einsel lens between the rf source and the exchange canal. (auth)

37997 MODIFICATION OF AN ION SOURCE FOR THE PRODUCTION OF MICROAMPERE $^4He^-$ BEAMS. John, Joseph; Robinson, C. P.; Aldridge, J. P.; Wallace, W. J.; Chapman, K. R.; Davis, R. H. (Florida State Univ., Tallahassee). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 82-6(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

Several modifications of the ion source of a model EN Tandem Van de Graaff Accelerator have increased the production of $^4He^-$ beams by a factor of 100 over that first obtained with the source (~10 nA). While using H_2 gas for charge exchange, the replacement of the source drift tube by a screen and the installation of a system for precise adjustment of the button alignment with respect to the extractor electrode increased the output to 150 nA at the ion source. Recently potassium vapor has been used for charge exchange. Since the introduction of this technique, $^4He^-$ beam currents of 1.2 μA have been regularly produced. The $^4He^+$ ions from a duoplasmatron ion source are accelerated to 20 keV and passed through the standard exchange canal which is modified by the addition of a potassium vapor chamber. Analyzed $^4He^{++}$ beams of 0.3 to 0.8 μA have been obtained with terminal voltage between 1.8 and 6 MV. The modified source has been used with K-vapor exchange for continuous periods of up to 120 hours without deterioration of source performance. Normal operation with H_2 gas exchange for other beams is possible without the interruption of the source operation. (auth)

37998 HIGH CURRENT ELECTRON GUN SUITABLE FOR USE DOWN TO 1 NANOSECOND PULSE LENGTH. Willard, J. (Vickers Ltd., Swindon, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 87-92(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

A triode electron gun is described which has been developed to meet the increasing interest in short pulse high current operation. The gun is of variable perveance capable of injecting at least 15 amps under short pulse conditions (1 nanosecond) and 1.5 amps under long pulse conditions (5 microseconds) with a beam diameter of 1 cm. Considerations of beam geometry have lead to the choice of a convergent flow Pierce-type gun incorporating an intercepting grid giving an amplification factor μo of 100 and a maximum beam perveance of 0.7 μP for the high current condition. A conventional oxide cathode is used. The cathode-grid structure, which is plug-in replaceable, forms part of a 50 ohm co-axial system mounted on the gun base from which a matched 50 ohm coaxial feeder is taken to the modulator. Some experimental results for long and short pulse operation are given. (auth)

37999 ELECTRON GUN FOR THE STANFORD TWO-MILE ACCELERATOR. Miller, R. H.; Berk, J.; McKinney, T. O. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 98-103(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

The design of the electron gun for an electron linear accelerator is of prime importance in achieving a small emittance volume and good reliability. Phase space concepts useful in gun design, the design of the SLAC electron gun, and tests of its performance are discussed. A convenient definition for the effective area in phase space of a finite set of calculated points is proposed and a discussion of the increase in transverse phase space within a linear accelerator is presented. The SLAC gun is a Pierce spherical triode with a 50-ohm coaxial input to the grid. The gun is designed to operate with 80 kV dc between the cathode and the anode. The current in the beam can be varied from 2 A peak to less than 10^{-3} A peak by varying the grid to cathode voltage over a range of about 1000 volts. The design permits use of either an oxide cathode radiantly heated or a thoriated tungsten cathode heated by electron bombardment. (auth)

38000 MULTIPLE BEAM PULSE CAPABILITY OF THE SLAC INJECTOR. Koontz, Roland F. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 104-9(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

The SLAC injector is capable of being programmed for multiple beams of different beam pulse width and intensity on a pulse to pulse basis. Programming is accomplished remotely from the central control building, two miles away. The beam starts at the SLAC gun which is a Pierce triode with cathode operated at −80 KVDC. The gun modulator drives the grid-cathode gap with an 800 volt pulse of selectable pulse width. Selectable grid-cathode bias controls the current output of the gun. These selections are made on a pulse to pulse basis as required for multiple beam operation. For time of flight experiments which require a series of very short pulses, or even a series of single bunches of electrons, a transverse sweeper phase locked to a subharmonic of the bunching frequency is used in the injector to chop the beam accordingly. (auth)

38001 MAGNETIC BOTTLE WITH ELECTRODES FOR TRAPPING LOW ENERGY ELECTRONS. Krisciokaitis, R. J.; Robinson, K. W. (Harvard Univ., Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 110-12 (June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

A device is described by which low-energy electrons can be trapped for a required period, in order for them to be polarized through spin-exchange collisions with polarized hydrogen atoms, for the production of an intense beam of highly polarized electrons. (B.G.D.)

38002 NEW DEVELOPMENTS IN HIGH VOLTAGE TECHNOLOGY. Trump, John G. (Massachusetts Inst. of Tech., Cambridge. High Voltage Engineering Corp., Burlington, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 113-21(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

The electrostatic and electromagnetic straight-line accelerators originated by Robert Van de Graaff for nuclear science have, for very heavy ions, moved toward the GeV level through advances in high voltage technology applied to the multi-stage (tandem) acceleration of multi-stripped ions. An account is given of the discreet steps in this exponential progress which depends basically on the maximum reliable voltage of one or a series of terminals. Recent studies on compressed gas insulation and on the control of electrical processes within long high-gradient acceleration tubes are described. These indicate the possibility of further substantial increases in terminal and column gradients applicable later to existing accelerators and to enlarged goals for new ones. (auth)

38003 MAGNETICALLY SUPPRESSED ACCELERATOR TUBES. Howe, F. A. (Atomic Weapons Research Establishment, Aldermaston, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 122-5(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

A method for effectively suppressing the electron loading in accelerator tubes is described, which utilizes transverse magnetic fields. The electron trapping is achieved without affecting tube optics or producing undesirable ion beam deflections at the tube exit, even when the stack voltage gradient is disturbed. (auth)

38004 DIFFERENTIAL PUMPING TUBE FOR ELECTROSTATIC ACCELERATORS. Howe, F. A. (Atomic Weapons Research Establishment, Aldermaston, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 126-8(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

A situation often exists in modern electrostatic accelerators where improved pumping speed is necessary for the removal of ion source or stripper gases and the obtaining of an acceptable degree of vacuum. The tube developed for this purpose at A.W.R.E. fulfills this purpose without degradation of machine performance. (auth)

38005 HIGH GRADIENT ACCELERATING COLUMN DESIGN AND CONSTRUCTION. Lee, G. M.; Curtis, C. D. (Midwestern Universities Research Association, Stoughton, Wis.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 129-33 (June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

A high voltage, high gradient accelerating column to provide good optics for high current beams has been built and tested by MURA. Design details were chosen to eliminate all possible sparking or corona discharges for reliable high voltage performance. The 12-in. accelerating gap features stainless steel spherical geometry electrodes shaped to produce a converging field. The electrodes are supported by titanium alloy spacers bonded to ceramic rings with a vinyl seal. There are 14 ceramic rings of 14 in. ID, 16 in. OD, and $1\text{-}^{15}/_{32}$ in. long, giving a column length of 21 in. This column is insulated externally by sulfur hexafluoride gas at three atmospheres absolute pressure confined by a fiber glass pressure shell. The completed column has been tested at 600 kV. Work is being done on ceramic-to-metal seals to eliminate organic materials. (auth)

38006 HIGHLY STABILIZED ELECTRON ACCELERATORS FOR ELECTRON MICROSCOPY AT EXTRA-HIGH VOLTAGES. Reinhold, G. (Emile Haefely and Co., Ltd., Basel). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 134-8 (June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

Interest in higher voltages for electron microscopy was stimulated by the successful operation of the world's most powerful electron microscope operating at a maximum voltage of 1.5 MV. Other installations have since been built covering the voltage range of 500 kV to 1 MeV. A 1 MeV electron accelerator of the new pressurized type design is being constructed. The dc power supply and the accelerator are housed in separate pressure vessels and connected by a shielded high voltage cable. Projects involving electron accelerators up to 4 MeV are now under consideration. (auth)

38007 FUTURE HIGH VOLTAGE DC POWER SUPPLIES OF THE SHIELDED DESIGN. Reinhold, G.; Truempy, K. (Emile Haefely and Co., Ltd., Basel). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 139-42(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

A large number of research laboratories are now using stabilized 600 kV dc power supplies of the entirely shielded design, with electronic ac supply and feed-back control systems. Recently, a new 600 kV power supply with a rated current of 20 mA has been marketed. At the present time, 1 MV dc power supplies which will operate in aluminum vessels under pressurized sulfur hexafluoride gas insulation are being constructed. The standard models have an overall stability including ripple voltage and noise of 1 part in 1000, both for continuous and pulsed operation. (auth)

38008 DAMPING COHERENT OSCILLATIONS IN THE AGS. Raka, E. C. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1091-5(June 1967). (BNL-11150).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

In order to further study the vertical instability in the Brookhaven AGS a narrow band feedback damping system was developed. The damping force is obtained from a pair of 6 ft long coils located in one of the straight sections. The damping signal is provided by a pair of pickup electrodes at an angle $\theta = 10.7°$ upstream from the coils. Since $\nu_y \cong 8.8$, $\nu\theta \cong \pi/2$. The damping is proportional to sin $[n\theta-(n-\nu)\ 2\pi\ foT]$ where n is the mode number, fo the rotation frequency and T the time delay between the pickup and damping elements. The system is designed to work over a range in fo from 200 kc to 370 kc. In this range, with T = .14 μsec, and for n = 7-11, the angle in brackets varies ±19° from $\pi/2$ if ν changes about ±1%. With a simple filter in the feedback loop it is possible to provide damping for the lower order modes n = 9, 8, 10, without exciting those for n = 7, 11, etc. under normal operating conditions. (auth)

38009 SIMPLE IMPROVEMENTS IN SMALL HIGH-VOLTAGE DC POWER SUPPLIES. Langsdorf, Alexander Jr. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 143-4(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

Simple improvements in small high-voltage dc power supplies are discussed. Topics include insulation, ripple, regulation, and component quality. (B.G.D.)

38010 DEVELOPMENT OF A 4 MV POSITIVE ION ACCELERATOR FOR HIGH BEAM CURRENTS. Reinhold, G.; Bill, J. (Emile Haefely and Co., Ltd., Basel). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 145-50(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The symmetrical 4 MV cascade generator is a dc accelerator power supply which provides both high voltage and high current capability at low ripple voltage. The problems usually encountered in the accelerating tube like total voltage effect, electron loading, and x-ray generation were solved by utilizing built-in permanent magnets for the deflection of the backstreaming electrons. This design reduces electron loading and brings the x-ray intensity down to a harmless level. With a rf ion source of conventional design, proton currents up to 1 mA at 4 MeV were actually obtained on the target. A further increase in the beam current is expected by the use of a duoplasmatron ion source. (auth)

38011 ORIGINAL NEUTRON GENERATOR USING A SHORT STRUCTURE ACCELERATING SYSTEM AND TURBOMOLECULAR PUMPING. Fremiot, C.; Muel, J. (CEN, Grenoble, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 151-6(June 1967).

From National Particle Acceleraor Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

A modified electrostatic generator is described for neutron production which possesses the following characteristics: fixed acceleration voltage, 240 kV; fixed beam diameter at target, 3 cm; fixed peak beam intensity, 10 mA; duty ratio, $1/_{100}$; and pulse length, variable from 100 μsec to 10 msec. A discussion is also presented on the characteristics and operation of a turbomolecular pump for the accelerator. (B.G.D.)

38012 MECHANICAL DESIGN CONCEPTS OF DYNAMITRON ACCELERATORS. Mason, C. F. (Radiation Dynamics, Inc., Westbury, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 157-60(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

On the basis of ready availability and reasonable cost, methyl methacrylate (lucite or plexiglass) has proven to be suitable for use as the structural material in the high voltage columns of Dynamitron accelerators. This material has reasonably high tensile strength, good machining characteristics, ready availability at reasonable cost, and good electrical properties such as high dielectric strength, high resistivity and resistance to surface tracking. The structures made of Acrylic material conform to standard forms of beam analysis provided deflections are kept within reason and stress within recommended limits. A 4.0 MeV column 15 feet long by 42 inches in diameter, supporting a

total weight of 1500 pounds is now in operation. The cinch rod method of supporting beam tubes has proven to be practical and allows several side benefits, such as easy handling, allowing for short sections of the tube to be replaced if damaged, ease of insertion of apertures if and when required, and assembly of modular sections to any given length desired. A new method, a combination of cinch rods and counter weights, has proven a satisfactory improvement that still has these desirable features without requiring unreasonable cinch rod tension. A 4.0 MeV tube 12 feet long, weighing 480 pounds and carrying an ion source, lens and getter-pump assembly weighing 55 pounds at the high voltage end is now in operation. (auth)

38013 AN IMPROVED CONTROL SYSTEM FOR VAN DE GRAAFF ACCELERATORS. Gere, E. A.; Lie, H. P.; Miller, G. L. (Bell Telephone Labs., Inc., Murray Hill, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 161-5 (June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

In an effort to improve the energy stability and operating convenience of the Rutgers-Bell FN Tandem, a study was made of the processes involved in the standard Van de Graaff corona stabilization system. In the light of these observations, a terminal voltage control system was designed using error signals derived both from the slit system and the capacity pickoff plates. The system operates using either the standard slit system, or the machines' Generating Voltmeter as the terminal voltage reference, switching automatically to the G.V. system when beam is lost for any reason. (auth)

38014 MULTI-LOOP FEEDBACK SYSTEM FOR DYNAMITRON VOLTAGE REGULATION. Thompson, C. C. (Radiation Dynamics, Inc., Westbury, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 169-73(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The stability of the Dynamitron high voltage generator is influenced by several factors: beam load changes, changes in the power mains, frequency components in dc anode power to the oscillator tubes, and modulation due to ac heated filaments. A brief analysis based on experimentally obtained data and the reasons for stabilizing the generated voltage by means of a multiloop feedback system are presented. Measurements made on a 3.0 MeV accelerator show that terminal ripple is 1500 volts peak-to-peak and that the regulation from zero to six milliamperes of beam is less than ±1500 volts. Future improvements in the generator and regulating electronics design should result in reducing the ripple to 600 volts peak-to-peak and the regulation to ±600 volts. (auth)

38015 NANOSECOND BEAM PULSING AND TIME-OF-FLIGHT SYSTEM FOR AN MP TANDEM. Purser, K. H.; Bahnsen, A.; Krick, M. S. (Univ. of Rochester, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 174-80 (June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

A pulsed beam and time-of-flight system was designed for a MP tandem Van de Graaff accelerator. The overall arrangement of the pulsing system and associated equipment is described. (B.G.D.)

38016 X-RADIATION FROM VAN DE GRAAFF ACCELERATOR ION SOURCES. Bernard, D. L.; Vo Long, N.; Rinehart, J. L. (Univ. of Virginia, Charolettsville). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 181-6(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The intensity of x radiation was measured as a function of positron along the ion source axis of the model IN and model CN positive ion Van de Graaff accelerators of the University of Virginia. The measurements were made with two x-ray spectrometers built to accommodate the different physical arrangements of the JN and CN accelerators. Back streaming electron beam profiles are deduced from the intensity distributions. Suggestions for reducing the x radiation emanating from the accelerators are given. (auth)

38017 IMPROVED SULFUR HEXAFLUORIDE GAS HANDLING SYSTEM FOR A POTENTIAL DROP PARTICLE ACCELERATOR. Marsik, S. J.; Stevenson, F. R.; Deraimo, J. C. (Lewis Research Center, Cleveland). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 187-90(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

An improved sulphur hexafloride (SF_6) gas handling system has been designed and built for the Lewis Research Center 3.0 MeV Dynamitron Accelerator utilizing the original components provided with the accelerator. The purpose of the system is to remove the gas from the accelerator when opening is necessary, purify and store it, and return it to the vessel. The advantages are; reduction in cycle time from 7 hours to about 3 hours, reduction in unretrieved gas from 7% to as little as 0.02%, compactness and improved purification resulting from liquefaction and additional filtering, and safe, reliable semiautomatic operation. Design considerations, fabrication techniques, and performance evaluation of the system are given. (auth)

38018 MIT HIGH DUTY, HIGH INTENSITY 400 MeV LINEAR ELECTRON ACCELERATOR. Bertozzi, W.; Haimson, J.; Sargent, C. P.; Turchinetz, W. (Massachusetts Inst. of Tech., Cambridge). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 191-6(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

A 400-MeV high duty ratio, high intensity linear electron accelerator is under design by the Laboratory for Nuclear Science of MIT under the sponsorship of the AEC. The design objectives are reported and component systems are described, including the buildings, rf power transmitters, beam centerline, beam transport system, and some experimental equipment planned for the facility. (auth)

38019 THE RF SYSTEM FOR THE AGS LINAC INJECTOR. Sheehan, J. F.; Lankshear, R. F.; Witkover, R. L. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 217-22(June 1967). (BNL-11188).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The rf system for the 200-MeV proton linac injector to be built for the AGS is described. The system will power 9 accelerator cavities at a frequency of 200 MHz. The rf system for the first cavity has to supply 1.5 MW of rf power. This is achieved by two identical 750 kW tetrode rf amplifiers feeding separate rf coupling loops. Cavities 2 through 9 require 1.5 MW of rf power. The rf system for cavities 2 through 9 are identical. Each system consists of: 5 MW rf amplifier, plate power supply, capacitor bank and crowbar, charge control amplifier, 350 kW rf amplifier, and modulator. (B.G.D.)

38020 DESIGN AND PERFORMANCE OF THE SLAC RF DRIVE SYSTEM. Farkas, Z. D.; Kruse, C. J.; Loew, G. A.; McConnell, R. A. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 223-8(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The design and performance of the rf drive system of the Stanford Two-Mile Linear Accelerator are described. The function of this system is to supply a drive signal of 240 watts to each of the 240-24 MW klystron amplifiers whose power accelerates the beam. The following subsystems are discussed: A highly stable tunable master oscillator at 476 MHz, a 17.5 kW CW main booster amplifier, a two-mile temperature stabilized 3-⅛ inch diameter main drive line, 30 times-six varactor frequency multipliers, 30 pulse modulators and sub-booster klystrons, 30 temperature stabilized 1-⅝ inch diameter subdrive lines, isolator-phase shifter-attenuators used before each sub-booster and 24 MW klystron, the phase-stable interconnecting cables, and standby equipment. (auth)

38021 RF SYSTEM DESIGN FOR THE SLAC STORAGE RING. Allen, M. A.; McConnell, R. A. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 229-33(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

In the proposed SLAC electron-positron storage ring, two one-ampere, 3-GeV beams will radiate energy at the rate of 1.13 megawatts with 880-kV peak voltage required for storage. This energy is restored through a six-cavity rf system operating at 50 MHz, the 36th harmonic of the rotation frequency. Of the total power over 90% will be delivered to the beams with the remaining part to the cavities and their associated networks. An experimental ultra-high vacuum cavity designed to operate at 200 kV peak across its accelerating gap and capable of dissipating 20 kilowatts in wall losses is described. The requirements of an automatic tuning and coupling system which will match continuously the cavity and the beam to the amplifier output are discussed. (auth)

38022 THE AGS CONVERSION RF SYSTEM. Tranis, A.; Kovarik, V.; Spinner, J. W.; Cottingham, J. G. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 234-6(June 1967). (BNL-11189).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The first step converting the Brookhaven AGS in order to increase its intensity by an order of magnitude will be to increase the capacity of the power supply to the extent that the cycling rate of the AGS can be doubled. The specifications for the conversion rf system are outlined and the equipment necessary to meet these specifications are described. (B.G.D.)

38023 THE AGS CONVERSION RADIO FREQUENCY POWER AMPLIFIER. Rheaume, R. H.; Sanders, R. T. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 237-40(June 1967). (BNL-11118).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

To double the rate of particle energy gain per unit time, to offset heavier beam loading and to remove the electronic components to a radiation-free area, the AGS radio frequency acceleration system must be redesigned and rebuilt. The new system will be capable of delivering a total of 1440 kW RF power into 12 pairs of 50-ohm coaxial transmission lines 1100 feet long, terminating at 12 accelerating stations. Voltage amplitude and phase responses are closely controlled over a working frequency range of 1.4-4.5 MHz. The AGS conversion radio frequency power amplifier is composed of twelve final power amplifier stages, driven in groups of six by two paralleled drivers. These latter units are in turn driven by a cascade of lower level predriver stages. The final and driver stages are identical push-pull wideband ferrite transformer coupled grounded grid triode circuits housed in separate enclosures, each with its necessary control and safety system. The predriver is a four stage push-pull amplifier cascade with grounded grid triodes and grounded cathode tetrodes and pentodes, initially excited by a fractional voltage input signal of the proper frequency and phase. The anticipated successful performance of the system is attributable to stable push-pull grounded grid amplifier configuration, to the carefully selected power tube complement and to the specially designed ferrite core interstage and output transformers and their associated networks. (auth)

38024 ACCELERATING SYSTEM FOR THE CORNELL 10 GeV ELECTRON SYNCHROTRON. Tigner, Maury (Cornell Univ., Ithaca, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 241-5(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

A system consisting of four lengths of iris loaded waveguide, each driven by an adjacent klystron amplifier, is described. These waveguides which serve as the accelerating elements for a 10 GeV electron synchrotron are operated in the $2\pi/3$ traveling wave mode at 714 MHz. The amplifiers have a common power supply and are driven from a common source which can be synchronized with the injector, a 150 MeV linac. (auth)

38025 RF POWER SYSTEM FOR THE SEPARATED-ORBIT CYCLOTRON EXPERIMENT. Mosko, S. W. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 246-9(June 1967). (ORNL-P-2988).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The SOCE is designed with 11 ratio frequency cavities (injector-3, buncher-2, SOC-6), each requiring up to 15 kW of rf drive power under full beam loading. A separate three-stage power amplifier unit using an Eimac 4CW25, 000A tetrode as the final amplifier is provided for each cavity. Each unit is provided with automatic servo tuning, and with precise phase and amplitude regulation. A master signal generator supplies a common 50-MHz drive signal, which also serves as the phase reference. Although requirements vary from one cavity to another, all power amplifier units are identical and connected to a single set of dc power supplies and controls. The components were designed conservatively so that the rf system could be operated at greatly increased power levels for high intensity beam studies, with only the addition of an auxiliary dc plate power supply. Most of the design features in the SOCE's multiple-amplifier radio frequency system will be directly applicable to later SOC-type accelerators, even for a much higher total rf power requirement. (auth)

38026 COMPACT RF SYSTEM FOR A 30-INCH AVF CYCLOTRON. Hendry, G. O. (The Cyclotron Corp., Berkeley, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 257-9(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The rf system for the 30-inch AVF cyclotron is described. A discussion of the design considerations and a summary of the performance achieved are included. Several unique design features are discussed. (auth)

38027 COMPACT 70MW, 250KV MODULATOR USING THYRATRONS. Latham, C. (Vickers Ltd., Swindon, Eng.); Menown, H.; Nicholls, N. S. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 260-5(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

A compact oil immersed modulator is described suitable for driving a 30MW output klystron and using two 70KV 2,500 Amp hydrogen thyratrons as switches. The design is a development of an earlier modulator using a 70KV triggered spark gap. This earlier model was limited to a maximum repetition rate of about 250 p.p.s. but the thyratron switches permit operation to over 1000 p.p.s. and a maximum duty cycle of .001. Complete oil immersion in a single tank results in compactness, economy, reliability and facilitates the use of a high charging voltage which, in turn, leads to a simplification in the pulse circuit, particularly in relation to pulse flattening and pulse length selection. A high current silicon clipper is described which is used to reduce the inverse voltage and which still permits rapid thyratron recovery time. (auth)

38028 KLYSTRON: AN ULTRA HIGH POWER RF ENERGY SOURCE. Reid, Don W. (Litton Industries, San Carlos, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 273-7(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

Each large particle accelerator which has been developed over the past years has been designed to yield information which was previously unavailable. Much of the design criteria depended upon the rf energy source available. The rf energy sources presently available are discussed. An extension is made to higher power tubes and the associated problems are discussed in detail. (auth)

38029 LOW DISTORTION RF AMPLIFIER VIDEO PULSES. Fox, Lowell J. (Litton Industries, San Carlos, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 278-81 (June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

Modern high energy particle accelerators require that the high power rf amplifiers generate rf waveforms which are essentially distortion free. This usually is accomplished through the use of very expensive and complicated high power regulation equipment. An alternate, relatively simple means of obtaining this regulation through the use of a unique high vacuum switch tube used directly in series with the rf amplifier is described. (auth)

38030 DESIGN OF TRAVELLING WAVE ELECTRON LINEAR ACCELERATORS. Gallagher, W. J. (Applied Radiation Corp., Walnut Creek, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 282-5(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

Various characteristics of two types of accelerating structures, constant impedance and constant gradient, are discussed. Among these were maximum energy gain, maximum beam power, maximum x-ray output, and zero power condition. (B.G.D.)

38031 RF PERTURBATION MEASUREMENTS IN LONG LINAC CAVITIES. Owen, C. W.; Radmer, C. A.; Young, D. E. (Midwestern Universities Research Association, Stoughton, Wis.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 286-9(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

Equipment and procedures have been developed for measuring the axial accelerating electric field in proton linear accelerator cavities. The method used is the usual one of measuring the change in resonant frequency caused by a small perturbing sphere on the axis of the cavity. The frequency change is determined at millimeter intervals along the axis by measuring the corresponding period length using an on-line digital computer. The computation is carried out on the computer so that the derived fields can be obtained, integrated, plotted, and compared. The method is rapid and the increased precision of the measurement allows better knowledge of the fields in operating linear accelerators. This equipment has been used on the 50-MeV linac injector for the Zero Gradient Synchrotron at Argonne National Laboratory. It has also been used to measure the axial field in a cavity with fields which can be calculated using a field computational program. The measured and calculated field values have been compared. (auth)

38032 STUDIES OF MULTISTEM DRIFT TUBE ACCELERATOR STRUCTURES. Giordano, S.; Hannwacker, J. P. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 290-4(June 1967). (BNL-11139).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

Three Alvarez-type drift-tube structures, the O, $\pi/2$, and π mode configurations, were examined in order to determine their relative merits in accelerating protons. The reduction of beam loading and tank detuning effects is discussed. (B.G.D.)

38033 NUMERICAL ANALYSIS OF THE RF FIELD IN A DRIFT TUBE LOADED CAVITY. Batchelor, K.; Nishikawa, T.; Werntz, T. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 295-302 (June 1967). (BNL-11193).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The normal mode analysis of standing wave linacs were shown to give a good representation of the fields existing inside the resonant cavity. In making the calculations it was assumed that the presence of drift tubes does not substantially affect the expressions representing the axial components of the normal mode fields. The assumption of a well-padded generator allows the effects of source impedance on the cavity build-up to be neglected. Effects due to a nonuniform beam bunch and space change effects of a high current beam line were also neglected. The improved field distribution resulting from a double feed to the cavity was also demonstrated. (auth)

38034 STUDIES OF MULTI-DRIVE EXCITATION FOR ALVAREZ STRUCTURES. Giordano, S.; Hannwacker, J. P.; Keane, J. T. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 303-6 (June 1967). (BNL-11136).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

To accelerate protons in an Alvarez type linac the cavity must be excited in the TM_{010}. For proper beam dynamics it is necessary that the rf amplitude and phase distribution along the length of the cavity be kept constant. The amplitude and phase variation along the tank are the result of both the propagation characteristics of the structure and the method used to excite the cavity with rf power. Measurements and analysis dealing with the effects of multi-drive systems are presented. The resultant improvements in the steady state and transient case are discussed. (B.G.D.)

38035 DESIGN OF A 3 AMPERE PEAK STEADY STATE, 0.001 DUTY, 10 MeV LINEAR ELECTRON ACCELERATOR. Whitham, Kenneth (Varian Associates, Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 307-11(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The centerline design of a 3 ampere steady-state linear accelerator is outlined and theoretical performance given. The techniques used for extending the blowup threshold are given along with pertinent cold test data. The injection system design is discussed along with methods used for handling high currents while providing 40-60° bunches. (auth)

38036 RF ACCELERATING CAVITIES FOR AGS CONVERSION. Rakowsky, G. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 315-19(June 1967). (BNL-11168).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The RF accelerating cavities at the Brookhaven AGS are of the balanced, coaxial type, filled with ferrite to allow permeability tuning. The basic limitation in such a cavity is heat dissipation in the ferrite. A study of the behavior of such a cavity as dc bias is applied to the ferrite is described. It is shown that rf flux density is inversely proportional to radius only at zero bias; as the bias current increases, the flux density approaches a nearly uniform distribution, resulting in nearly uniform heating. The results are applied to the problem of increasing the operating voltage of the present AGS cavities as well as to the design of a new cavity for the AGS conversion project. (auth)

38037 COAXIAL CAVITIES FOR SEPARATED ORBIT CYCLOTRONS. Ziegler, N. F. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 331-5(June 1967). (ORNL-P-2992).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

Coaxial cavities are recommended over TM cavities for use in separated-orbit cyclotrons (SOC's) under 100 MeV primarily because they are smaller and construction tolerances are less stringent. At some energy above 50 MeV, however, the TM cavity becomes more efficient. Particles can gain energy in a coaxial cavity with arbitrary spacing between gap centers; however, maximum energy gain occurs for a spacing of $0.5\beta\lambda$. In a multi-particle SOC a spacing can be selected to provide acceleration of several different particles. It becomes impractical to define modes in a coaxial cavity relative to the beam motion since the primary TEM mode is defined relative to the direction of wave propagation in the transmission line. Thus TE modes in this paper are likewise defined. The TE modes in a coaxial cavity produce an accelerating voltage which varies with machine radius. Three coaxial cavities have been constructed at ORNL. RF measurements on a $\frac{1}{4}$-scale model of a 50-MeV cavity and on the SOCE model have been completed. The 50-MeV prototype cavity is now ready for testing. (auth)

38038 LOW TEMPERATURE ASPECTS OF A CRYOGENIC ACCELERATOR. Schwettman, H. A.; Turneaure, J. P.; Fairbank, W. M.; Smith, T. I.; McAshan, M. S.; Wilson, P. B.; Chambers, E. E. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 336-44(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The many low temperature aspects of a cryogenic accelerator are discussed. The relation of these aspects to the operating characteristics which might ultimately be achieved is examined. (auth)

38039 ACCELERATING STRUCTURES FOR SUPERCONDUCTING ELECTRON LINACS. Weaver, J. N.; Smith, T. I.; Wilson, P. B. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 345-9(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

A study to determine the optimum slow wave structure for a superconducting linear accelerator is being conducted. Vacuum, thermal, and mechanical problems at cryogenic temperatures impose limitations on such structures. Ultimately, the maximum energy gradient in a superconducting structure is limited by the critical magnetic field or electric field breakdown. At present a $\pi/2$, biperiodic, standing-wave structure is favored. Calculations of the dispersion diagram and longitudinal electric field profile has been obtained from a coupled resonator, normal mode analysis. A comparison is made with room temperature measurements on stacked test cells. The effects of full end cells and of incorrectly tuned cells on the flatness of the electric field profile are considered. The relationship between cell tuning and the presence of a stop band in the dispersion curve is shown. Problems of coupling to a high Q superconducting structure and tuning the frequencies of sections in a multi-section linac are considered. Results are given for the Q, the dispersion diagram, and the energy gain for a 952 MHz lead-plated superconducting structure 5 feet in length operating near 2°K. (auth)

38040 PROPOSED MICROWAVE SYSTEMS FOR SUPERCONDUCTING RADIOFREQUENCY BEAM SEPARATORS. Halama, H. J.; Hahn, H. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 350-5(June 1967). (BNL-11121).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

Various aspects of the microwave system for rf beam separators using superconducting iris-loaded deflectors are discussed. This microwave system differs significantly from a conventional design. The differences stem mainly from the very high Q, the mandatory standing wave operation, and the lack of frequency adjustments by temperature changes. Successful operation of the separator depends on keeping two narrow bandwidth resonators ($\Delta f \approx 20$ Hz) at the same frequency, $f_0 \approx 1.3$ GHz, and in rigid phase relationship. Mechanical tuning of the deflectors must be provided in the form of a variable path length for a resonant ring or in the form of an adjustable short for a resonant cavity. The resonant deflector can be powered either from a common source or by using the deflector as frequency determining element in an oscillatory system. Both microwave systems are described and their relative merits are compared. (auth)

38041 FUTURE OF SUPERCONDUCTING MAGNETS. Laverick, Charles (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 361-71(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

Some advantages and limitations to the use of superconducting coils in preference to conventional copper coils are mentioned. The current commercial availability of superconducting material is outlined and recent trends in conductor development are discussed. Some of the best recent magnets are mentioned and performance figures given. Definite plans for several larger coils which can be expected to operate within the next four or five years are described and some speculations on the most likely areas of application are made. Possible applications of superconductors to Accelerators and Accelerator Experimental Area use are also

indicated. A brief assessment of some future trends is made and some possibilities for future studies are indicated. (auth)

38042 EFFECT OF FAST NEUTRON IRRADIATION AT LOW TEMPERATURE ON NbZr COIL PERFORMANCE. Benaroya, R.; Blewitt, T. H.; Brooks, J. M.; Laverick, C. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 383-5(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The effects of exposure to fast neutron radiation on the performance of a superconducting NbZr solenoid are reported. The irradiations and tests were carried out with the coil held near its operating temperature. Performance was determined by measuring the maximum current at which the coil quenched. Secondary irradiation from the 60-in. ANL Cyclotron (1.2×10^9 neutrons/cm^2/s at 3-13 MeV, peaked at 8 MeV) had no measurable effect upon the operation of the coil. At the ANL CP-5 reactor, a total dosage of 7.2×10^{17} neutrons/cm^2 (fission neutrons above 0.7 MeV) caused no deterioration in the coil. A slight enhancement (2 to 3%) of coil performance was observed but this annealed out at room temperature. An exposure rate of 8.3×10^{11} neutrons/cm^2/s produced sufficient nuclear heating to give severe degradation in coil performance to 20% of the initial quench current. (auth)

38043 ELLIPTICAL AND CIRCULAR CURRENT SHEETS TO PRODUCE A PRESCRIBED INTERNAL FIELD. Beth, Richard A. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 386-8 (June 1967). (BNL-11145).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

Any desired two-dimensional magnetic field, which is compatible with Maxwell's equations in empty space, can be produced inside a given elliptic or circular cylinder by a distribution of currents flowing along the elements of the cylinder. Formulas are given for the required current distribution, the resulting external field, and for the total field energy in the internal and external regions. It is further possible to eliminate the external or stray field completely while producing the prescribed inner field by adding a second confocal elliptic (or coaxial circular) current sheet. Formulas are given for the required current distributions. To facilitate their use the formulas are here presented unencumbered by derivations but in a form which makes the correspondence between the elliptic and circular cases, as well as the specialization to median plane fields, appear as simply as possible. (auth)

38044 THEORY, DESIGN, AND MEASUREMENT OF THE BROOKHAVEN NARROW QUADRUPOLES. Danby, G. T.; Jackson, J. W. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 414-19(June 1967). (BNL-11128).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

A novel approach is presented which results in mechanically simple quadrupoles producing high field gradients with modest power consumption and with very small aberrations. These lenses can be assembled either in four-fold geometrically symmetrical versions or in narrow septum versions without side yokes. The asymmetrical version conserves the very valuable space available for small angle secondary beams. There is no deterioration of optical properties since the four-fold magnetic symmetry is maintained in the aperture region. In addition, the fringing field is quite small. A unique magnet profile was adopted. Most general purpose iron quadrupoles are derived from the concept of four identical hyperbolic pole profiles which are quadrupole equipotentials. However, for a practical design this geometry must be severely distorted to provide space for reasonable current density coils. The present conceptual approach is to abandon the hyperbolic idea completely and treat the problem from the viewpoint of its four-fold symmetry which permits only $r^2 \sin 2\theta$, $r^6 \sin 6\theta$, $r^{10} \sin 10\theta$, etc., potential terms. Since these terms increase as the fourth power in their spatial variations, their magnitudes can be separately controlled with properly chosen physical perturbations. Using this method a quadrupole of high optical purity was produced employing a simple iron profile composed only of plane surfaces. (auth)

38045 DRIFT TUBE QUADRUPOLES. Otis, A. N.; Damm, R. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 420-4(June 1967). (BNL-11165).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The 200-MeV proton linac injector for the AGS conversion will have a focusing magnet in each of its 274 drift tubes. A development program has been underway to produce the required quadrupole magnet designs. Both dc and pulsed power prototypes were fabricated and tested. It was found that the pulsed magnet design achieved substantially higher gradients than the dc powered design. The pulsed magnet design is a scaled-down version of the Danby-Jackson narrow quadrupole. Measurements of harmonic content have been taken by the AGS magnetic measurements group. Thermal tests were conducted and their results are discussed. All tests were performed on magnets designed to fit into the first full drift tube of the injector. (auth)

38046 AGS LOW FIELD CORRECTION ELEMENTS. Herrera, J. C.; Lasky, C.; Month, M. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 425-30(June 1967). (BNL-11138).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The Brookhaven Alternating-Gradient Synchrotron accelerates protons from an injection energy of 50 MeV to a final energy of 30 GeV. During the initial phase of the process, the motion of the particles is determined primarily by the injection fields and their gradients existing along the half mile circumference of the machine. The effects of linear magnetic components on the motion of these low energy protons are considered. Super-period quadrupoles and dipole elements are tested in detail. A summary of the characteristics of other linear components is also included. (auth)

38047 MAGNET DESIGN FOR A VERY HIGH ENERGY SYNCHROTRON EMPLOYING A SEPARATED FUNCTION MAGNET LATTICE. Danby, G. T.; Allinger, J. E.; Jackson, J. W. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 431-6(June 1967). (BNL-11149).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

It is shown that for a very high energy proton synchrotron a separated function magnet lattice is superior to the conventional combined function lattice. Topics discussed are the magnetic properties of the two types of components, beam optics and tolerances, and comparisons of the two lattices. (B.G.D.)

38048 METHODS OF COMPUTING THE TIME CONSTANT AND IMPEDANCE OF MAGNETS. Praeg, Walter F. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 437-41(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

For regulation and ripple studies of dc magnets, the essential parameters which must be known as a function of dc magnetization and/or frequency are the unit step time constant and impedance. An exact value for the unit step time constant of a laminated or solid core magnet can only be obtained by measurement. It can, however, be estimated from the dc time constant which is easily computed from the magnet geometry, number of coil turns, and the coil resistance. Measured unit step time constants and computed dc time constants are given for a number of magnets. Formulas to compute the impedance of laminated core magnets are developed. An empirical formula for calculating the impedance of solid core magnets is deduced from test data. (auth)

38049 THE BEAM TRANSPORT SYSTEM OF THE MICHIGAN STATE UNIVERSITY CYCLOTRON. Mackenzie, G. H.; Kashy, E.; Gordon, M. M.; Blosser, H. G. (Michigan State Univ., East Lansing). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 450-5(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The novel design features and associated ion-optical calculations of the Michigan State University Cyclotron beam transport and analysis system. It consists principally of two n = 0 circular bending magnets, each bending 45°, combined with quadrupole lenses to give vertical focusing such that $\nu_z = 2\nu_r$. (B.G.D.)

38050 FAST SEQUENCING BIPOLAR ENERGY DISCHARGE SYSTEM FOR THE BEAM BUMPER MAGNET IN THE ZERO GRADIENT SYNCHROTRON. Hornstra, F. Jr.; Varga, H. J. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 464-7(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

An energy discharge system was constructed which permits repetitive pulses spaced 30 ms apart or greater to the Zero Gradient Synchrotron (ZGS) beam bumper magnet. To allow beam bumping to either side of the equilibrium orbit, each pulse is independent in polarity and magnitude. Two pulses per machine cycle are provided, but the system is being expanded to five. The system consists of the beam bumper magnet time-sharing two inde-

pendent energy storage subsystems each containing two series ignitrons, one for each polarity and two crowbar ignitrons, one for each polarity. A logic system automatically triggers the crowbar associated with a given subsystem. An early crowbar trigger can be used which shunts the coil well before peak current occurs reducing the peak current on a given pulse. Each subsystem contains a 2 A, 14 kV power supply and 450 μF of capacitance. The beam bumper magnet has a 4-turn coil which may be connected either in parallel or series. The inductance for one turn is 1.6 μH. The beam may be targeted or extracted in less than 20 μs or as long as several hundred μs, depending on the choice of C and L. If exceptionally long times are needed, the subsystems may be interconnected causing all capacitors to be in parallel. (auth)

38051 ESTABLISHMENT OF PRECISE MAGNETIC FIELDS IN THE MOMENTUM ANALYZING SYSTEM AT SLAC. Seppi, E. J.; Cobb, J. K.; Jensen, D. R. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 473-7(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

Precise magnetic fields are necessary to achieve high-quality particle beam-transport in the SLAC beam switchyard. A discussion of the methods of magnetic measurements associated with testing and establishing these fields is presented. These measure ments and some of the important results obtained are described. In order to satisfy the criteria placed on the transport systems each magnet was measured and the critical magnets of the transport system were selected for placement in the beam switchyard on the basis of several of their measured characteristics. A description of the selection procedure is presented, and the effects of the individual magnet differences are discussed. Details of measurement techniques and the resulting procedures which are used for setting up the beam switchyard for a particular momentum are given. (auth)

38052 INFLUENCE OF MAGNETIC ELEMENTS ON AN ISOCHRONOUS CYCLOTRON FIELD. Theus, R. B.; Allas, R. G.; Davisson, C. M.; Pieper, A. G. (Naval Research Lab., Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 487-92(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

One of the main advantages of using magnetic field measuring equipment supported external to the cyclotron magnet is the ability to map the field before and after installation of the extraction elements. Field measurements with extraction elements in place are usually precluded by the size of internally mounted field mapping equipment (e.g., a wheel). The magnetic field of the NRL-isochronous cyclotron was measured to full radius before installation of extraction elements. After installation the influence on the magnetic field of each extraction element energized separately was measured. These measurements were used to determine the perturbation of the extraction channel on the isochronous field. Ion orbit calculations were then used to determine necessary field corrections to accelerate ions to the extraction radius. These field corrections are translated to currents needed in each of the various coils via a least squares fitting program. (auth)

38053 THE 200-MeV ELECTRON–POSITRON STORAGE RING MAGNET POWER SUPPLY. Hicks, John W. (Midwestern Universities Research Association, Stoughton, Wis.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 493-5(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

Two 250 V-100 kW amplidynes are controlled to give a precise output current. The load consists of the series connected bending and quadrupole magnets for the 200-MeV storage ring. This load has an inductance of 0.46 H and a dc resistance of 0.8Ω. The magnet current is composed of dc and a triangular-shaped component at a frequency of 3 Hz. This frequency is an order of magnitude higher than the break frequency of the magnet load. The control elements act as an integrator, a summing amplifier, and a differentiator on the error signal and as a differentiator on the reference input. A gain change takes place during the cycle to compensate for saturation of the amplidyne. An electrical analog was used to determine the best range of values for the various control elements. The amplidyne drive is a high slip induction motor that also serves the purpose of smoothing out the electrical load on the power line. (auth)

38054 A MEGAWATT SOLID-STATE INVERTER TO POWER THE CORNELL 10 GeV ELECTRON SYNCHROTRON. Kellers, C. F.; Littauer, R. M. (Cornell Univ., Ithaca, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 496-9(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

An inverter circuit was constructed using only solid-state components, rather than ignitrons, to power the Cornell 10-GeV electron synchrotron. Inverter operation, softening networks, and delay line modes are discussed. (B.G.D.)

38055 FLAT TOPPING THE PPA SYNCHROTRON MAGNET. Huttar, D.; Riedel, J. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 503-6(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

A project is currently under way at the Princeton–Pennsylvania Accelerator to modify the Synchrotron Magnet Circuit in such a way as to make flat topped operation available for up to 50% duty. Whereas, the magnet circuit is now resonant at approximately 19Hz and the magnetic field is a sinusoidal function of time, flat topping will permit latching the field at its peak value (corresponding to 3 GeV) for up to 50 milliseconds. Flat topping is to be achieved by short circuiting the capacitors of the circuit at the appropriate time and regulating the magnet current with series power supplies. The resulting pseudo acyclic operation requires that the rotating machinery presently used to excite the circuit be replaced by all electronic sources. All electronics will be solid state. (auth)

38056 PROTECTIVE RELAYING AND MONITORING OF THE RING MAGNET POWER SUPPLY FOR THE ARGONNE NATIONAL LABORATORY ZERO GRADIENT SYNCHROTRON. Visser, A. T. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 507-11(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

A description and relaying flow diagram presents the protection and monitoring system presently used in the 115 MW peak pulsed ring magnet power supply (RMPS). (auth)

38057 FAULT DETECTION IN SYNCHROTRON MAGNET COILS. Rohrmayer, Alfred (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 512-16(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

Curves were developed which show the currents in the shorted turns, the voltages across a faulted coil, and the heat losses developed, all as a function of the fault resistance. These show that with decreasing fault resistance, all faults will damage the conductor by melting the copper at the point of fault. Existing relays cannot prevent the damage. Impedance measurements, which can detect turn faults at an incipient stage, have been suggested. (auth)

38058 THE FAILURE OF THE ALTERNATORS OF THE NIMROD MAIN MAGNET POWER SUPPLY. Brooks, H. C. (Rutherford High Energy Lab., Chilton, Eng.); Reed, A. B. D. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 517-21(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

The failure of one of the two magnet power supply alternators which resulted in the rewind of one stator and the modification and rebuild of the rotors of both alternators is described. This failure prevented Nimrod operating at 7 GeV from late February, 1965, to the end of November, 1965. Certain design changes made when the rotors were rebuilt are described. A résumé is given of the investigations carried out immediately after the failure, while rebuilding was in progress, and after the machines were returned to service. Present plans are also briefly mentioned. (auth)

38059 ELECTRON LINAC INSTABILITIES. Loew, G. A. (Stanford Linear Accelerator Center, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 529-40(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

The present state of understanding of electron linac instabilities which result in beam loss along the accelerator is summarized. The major emphasis is placed on the type of instability which is caused by cumulative interaction of the beam with a multisection accelerator, as distinguished from the effect observed in short high-current accelerators where the instability is due to local regenerative interaction. The manifestations of the effect are first described and physical models are proposed. The properties of the HEM_{11} mode which is responsible for the instability

are discussed in detail. Following, a short summary of the Panofsky theory is presented to illustrate various scaling laws which have been verified experimentally on the SLAC accelerator. Measured results are also compared with a detailed computer study made by R. Helm and agreement is generally found to be very good. After the discussion of beam break-up gain, a few conjectures are presented on the possible starting mechanisms of the effect. In conclusion, the program presently underway at SLAC to increase the current threshold of the instability is outlined and early results of this program are presented. (auth)

38060 METHOD OF COMPUTING GENERALIZED ORBIT CONSTANTS IN SYNCHROTRON LATTICES. Morgan, G. H. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 541-5(June 1967). (BNL-11045).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

Collins presented a method of graphical evaluation of certain orbit constants for alternating-gradient synchrotron lattices of the FODO type. His paper does not describe the process for obtaining the constants, which appears to have been by a combination of exact numerical solutions and analytic approximations. A process suitable for an electronic computer is described and orbit constants for FODO and several other lattices are presented. FOFDOD, FDO and the mirror pair DFFDO and FDDFO. In all cases, the results apply to simplified lattices with no drift spaces other than indicated by the O and with identical focusing and defocusing magnets. End effects are ignored, i.e., the magnets are sector magnets curved to match the synchrotron ring curvature, with end faces normal to the center line. (auth)

38061 STUDIES OF RESONANT SYNCHROTRON OSCILLATION EFFECTS USING MOSER TRANSFORMATIONS. Steben, J. D.; Meier, H. K.; Symon, K. R. (Midwestern Universities Research Association, Stoughton, Wis.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 546-51(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

Nonlinear synchrotron oscillations are present in virtually all accelerators (for economic reasons). For rf parameters likely to be used in 600-1000 GeV accelerators, or in high frequency (high harmonic) rf systems at lower energies, these nonlinearities give rise to numerous resonances, including basic noncoupled resonances which the present study investigates both by analytical and computational methods. A relatively simple theory was sufficient to explain qualitatively many effects, such as propellers and beads in phase space, for both third- and half-integral resonances. Some extensions of the work of Symon et al. (Proc. of Int'l Conf. on High Energy Accelerators (Frascati, 1965)) are reported. However, understanding some details of the $\nu = \frac{1}{4}$ resonance was not possible without the use of Moser transformations. In particular, a null occurs in the resonance driving term as the synchronous particle phase Φ_S is varied, an effect predicted by the Moser theory. The results indicate that suitably designed particle accelerators may operate in the vicinity of some phase oscillation resonances but that the resonances in question influence the desirable choice of Φ_S. (auth)

38062 ORBITS IN FIXED FIELD ALTERNATING GRADIENT SYNCHROTRON. Chien, C. S. (Midwestern Universities Research Association, Stoughton, Wis.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 552-6(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

An analytical investigation was made of the motion of a charged particle in an axially symmetric steady magnetic field. For a given momentum, expressions for the shape of the equilibrium orbit and betatron oscillation frequencies were derived in terms of the field index k, the spiral parameter K, and a set of field coefficients g_{rm}. These algebraic results were programmed for the IBM 704 computer. For a 500 MeV fixed field alternating gradient (FFAG) synchrotron designed as an injector, computations yield radical and vertical tunes averaged with respect to momentum of $\nu_R = 3.23$, $\nu_z = 2.37$ with variations of $|\Delta\nu_r| \leq 0.0001$, $|\Delta\nu_z| \leq 0.0004$ depending on the exact momentum. For comparison, Runge-Kutta evaluations which require a factor of six longer computing times yield average tunes of $\nu_r = 3.22$ and $\nu_z = 2.49$. (auth)

38063 REVISED LINAC BEAM DYNAMICS EQUATIONS. Schnizer, B. (European Organization for Nuclear Research, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 557-61(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The set of equations for proton linac beam dynamics given by P. Lapostolle at the Frascati Conference (1965) is derived again by a more rigorous method and extended to include relativistic effects. This is accomplished by a systematic classical perturbation theory using expansions with respect to small perturbation parameters, one describing the influence of the field on the free-particle motion, the other relativistic effects. This permits estimates of the accuracy. (auth)

38064 THEORY OF LONGITUDINAL INSTABILITIES IN SYNCHROTRONS, WITH APPLICATIONS. Pease, Robert L. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 562-6(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

By combining the results of longitudinal instability theory and synchrotron oscillation theory, it is possible to derive two simple and useful expressions for longitudinal instability particle threshold. The first, which holds at injection, is given directly in terms of design parameters; in practical cases it turns out to depend only slightly on injection energy and to be independent of field index and vacuum chamber size, provided only that the vaccum chamber is large enough to contain particle oscillations. The second, which is based on adiabatic bunch behavior, displays the variation of threshold with energy; it decreases monotonically from injection to transition (if a real transition exists) and then increases monotonically. Different regions of this universal curve are relevant, depending upon whether the machine considered is a booster, a weak-focusing machine, or a standard AG synchrotron in which transition is crossed. Practically, it appears that recently proposed boosters will be free from longitudinal instabilities if a little care is exercised in design. It is quite evident that proposed "improved" AG machines will have no problems at injection; the treatment of the transition region is still crude, and further analysis will be required for a definite answer—it appears that there might be trouble at least in Phase II (2×10^{13} protons) unless the capture at injection is extremely efficient. (auth)

38065 BEAM-ENVELOPE OSCILLATIONS WITH SPACE CHARGE IN CIRCULAR PARTICLE ACCELERATORS. Lapostolle, P. M.; Thorndahl, L. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 567-71(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

Properties of matched beams (definition: beams whose dimensions oscillate with the periodicity of the machine) and their stability, are discussed. At intensities beyond resonances several matched solutions exist. It is shown that it may be possible to achieve an increase in the number of accelerated particles by injecting at those intensities and by crossing the resonances subsequently during acceleration. (auth)

38066 DESIGN OF A HIGH INTENSITY PROTON LINEAR ACCELERATOR. Lapostolle, P. M. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 572-6 (June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

In the CERN linear accelerator, intensities above 125 mA have been accelerated. For very big, present and future AG synchrotrons, however, there is a need for injectors giving 200 mA or more. At this intensity level, very strong longitudinal space charge effects occur which limit the phase stability in linacs and which also have been shown to prevent efficient bunching with conventional bunchers. Proposals are given to raise the limit of these effects to about half an ampere where beam loading compensation may become difficult. For a better prediction of the performances, several studies are still to be made and various methods are outlined; a few difficult points may, however, require further effort, especially if still higher intensities and extreme performances are needed. (auth)

38067 COMPUTER CALCULATIONS OF EFFECT OF SPACE CHARGE ON LONGITUDINAL BEAM DYNAMICS IN PROTON LINEAR ACCELERATORS. Benton, A.; Chasman, R.; Agritellis, C. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 577-80(June 1967). (BNL-11137).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

Results of computer calculations of the effect of space charge on longitudinal beam dynamics in a proton linear accelerator are presented. All computations were done on the CDC 6600 computer at BNL. The machine parameters used are those of the existing 50-MeV injector linac for the AGS. (B.G.D.)

38068 SPACE CHARGE EFFECTS IN HIGH CURRENT LINEAR ELECTRON ACCELERATOR INJECTION SYSTEMS.

Williams, C. B. (General Atomic Div., General Dynamics Corp., San Diego, Calif.); MacGregor, M. H. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 581-5(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

One of the simplest types of injection system used on the linear electron accelerator consists of an electron gun, a prebunching cavity or cavities and the first part of the accelerating waveguide itself. One of the first problems encountered in the design of an injector is to determine the phase and energy spread of the beam injected into the accelerating waveguide. For an accurate calculation it is necessary to include the effect of the beam pipe which functions as a grounded conducting cylinder surrounding the beam and also the longitudinal space charge defocusing forces which exist, in high current modes of operation. A number of simplifying assumptions were made in order to clearly present these two particular effects. Only a single cavity system was considered although the extension to a two or more cavity system can be readily accomplished. Radial space charge defocusing forces are also present which can significantly affect the bunching process. In this presentation it was assumed that a suitable magnetic field was applied to confine the beam and resulting secondary effects were neglected. A computer code was developed which traces the electron beam parameters from the prebunching cavity through the drift space up to the critical pre-relativistic region of the accelerator itself. For an accurate calculation, one rf cycle of beam must be divided into at least fifteen axial spatial divisions. The electrons within these divisions interact nonlinearly with one another during the course of the bunching process, necessitating an accurate step-by-step procedure. A number of examples were taken which illustrate the performance of this simple type of injection system in the high current mode of operation. (auth)

38069 RELATIVISTICALLY CORRECTED THREE DIMENSIONAL SPACE CHARGE ANALYSIS OF ELECTRON BUNCHING. Haimson, J.; Mecklenburg, B. (Massachusetts Inst. of Tech., Cambridge). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 586-93(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

A technique for evaluating the radial and longitudinal forces present within a moving volume of charge is presented. For an assigned array, based on a given set of initial conditions, the bunch is replaced by a volume mesh comprising a series of cylinders and surrounding annuli. The coordinates of these elements are monitored to provide changing charge distribution and bunch shape information during the trajectory. Owing to the rigorous design requirements of the MIT high duty factor linear accelerator, studies have concentrated on the problems of attaining monochromatic bunches of small dimensions suitable for injection into the accelerator waveguide system. Concomitantly, voltage depression effects and reduction of space charge fields due to the presence of conducting walls are included in this presentation. (auth)

38070 SPACE-CHARGE EFFECTS ON THE QUADRUPOLE FOCUSING SYSTEM IN LOW-ENERGY PROTON LINEAR ACCELERATORS. Ohnuma, Shoroku; Vitale, Joseph N. (Yale Univ., New Haven). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 594-601(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

A general computer program was used to calculate the stability diagram for (+)(−)(+)(−) quadrupole arrangements when the space charge is uniformly distributed in an elliptic cylinder or an ellipsoid. Linearized equations for longitudinal and transverse envelopes of the bunch were solved simultaneously in order to find the velocity dependence of the phase damping. (auth)

38071 THROBBING BEAM INSTABILITIES IN PARTICLE ACCELERATORS AND STORAGE RINGS. Lee, M. J. (Stanford Linear Accelerator Center, Calif.); Morton, P. L.; Mills, F. E. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 602-6(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

Finite conductivity of the vacuum chamber wall can cause unstable coherent transverse oscillations of the center of charge and also oscillations of the transverse cross section of a beam of charged particles. The former case, which can be characterized by a dipole oscillation, has been studied extensively by others. A study was conducted of the cross sectional oscillations of a nearly circular beam centered in a circular pipe, and a self-consistent solution has been obtained for both monopole and quadrupole oscillations. Dispersion relations for the oscillation frequencies have been found, and conditions for stability have been deduced. For the quadrupole instability the growth rate and threshold are very close to those obtained for the dipole instability, differing only by a geometrical factor of order unity; whereas, for the monopole instability, the growth rates are so small that the oscillations in present electron accelerators and storage rings will be suppressed by radiation damping. (auth)

38072 SPACE CHARGE DEFOCUSSING OF BUNCHED BEAMS. Gallagher, W. J. (Applied Radiation Corp., Walnut Creek, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 607-11(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

The problem of dispersion due to space charge is investigated using electromagnetic theory. The electrodynamic problem was solved in the stationary (or laboratory) frame, using the electromagnetic fields in that frame, and in a moving frame, using electrokinetic forces (no magnetic fields) and to translate the observations into the laboratory frame using the Lorentz transform. (B.G.D.)

38073 LONGITUDINAL SPACE CHARGE EFFECTS IN RF BUCKETS. Trzeciak, W. S. (Midwestern Universities Research Association, Stoughton, Wis.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 612-23(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

Longitudinal space charge effects in RF buckets were studied by means of an IBM 704 computer program. This program simulates the motion of the particles in a beam under the influences of space charge forces and rf fields. Initially, the beam is given a small perturbation to excite a particular mode. Stable and unstable beams with energy spreads much greater than, approximately equal to, and much less than the energy spread of an rf bucket in the absence of space charge forces were studied. Duplicate runs are made with and without space charge forces and the results are compared. After a transitional period of time, with space charge forces acting, the stable phase region assumes a characteristic diamond shape which persists for more than five synchrotron periods. This stable phase region contains more particles than the corresponding rf bucket in the absence of space charge forces. When the initial distribution of particles in phase space is independent of phase angle and has an energy spread much less than the energy spread necessary to stabilize the beam against the negative mass instability, large clumps of particles form immediately. These clumps of particles execute phase oscillations and may coagulate with the particles in the stable phase region. If particles far from the stable phase region do not interact with particles in the stable phase region, the bucket assumes an elliptical shape, very narrow in phase angle, large in energy spread, with a lifetime of more than five synchrotron periods. (auth)

38074 COMPUTER STUDIES OF ORBITS IN HIGH ENERGY MICROTRONS. Robinson, C. S.; Jamnik, D.; Hanson, A. O. (Univ. of Illinois, Urbana). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 624-9(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

Several types of orbit calculations performed to study the feasibility and design features of a superconducting 600-MeV split microtron being planned for the University of Illinois are reported. Programs were written for the Illinois IBM 7094 computer to study phase stability in the presence of magnetic field inhomogeneities, vertical defocusing produced by the magnet fringing fields, and axial and radial motion of electrons in the accelerating linac. (auth)

38075 BEAM MEASUREMENTS IN THE HARWELL VARIABLE ENERGY CYCLOTRON. Lawson, J. D. (Rutherford High Energy Lab., Chilton, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 635-40(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

The interpretation of probe measurements of beam behavior in the cyclotron is discussed with reference to results obtained with the Harwell Variable Energy Cyclotron. (auth)

38076 RESISTIVE WALL INSTABILITY AND DAMPING SYSTEM IN NIMROD. Gardner, I. S. K.; Harold, M. R.; Rees, G. H. (Rutherford High Energy Lab., Chilton, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 653-9 (June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

Observations of the resistive wall instability in Nimrod are described. An account is given of the system used to damp the (1–Q) mode of the instability. (auth)

38077 USE OF A DEBUNCHER TO OBTAIN VARIABLE ENERGY FROM A LINEAR ACCELERATOR BEAM. Myers, W.; Abraham, J. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 666-9(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The rf system requirements and components are described for a debuncher used to obtain variable energy from a linear accelerator beam. (B.G.D.)

38078 ADJUSTMENT AND TEST OF THE 300 MeV EXTRACTION SYSTEM FOR THE NASA 600 MeV SYNCHROCYCLOTRON. Younger, Francis C. (William M. Brobeck and Associates, Berkeley, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 677-83(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

A regenerative system for extracting 300-MeV protons from the NASA 600 MeV synchrocyclotron at Langley Research Center was installed and tested. This system, which brings the protons out of the accelerator through a 20-foot long channel from a point almost half of the normal exit radius, was designed to have some manual adjustments of the iron components to produce the magnetic field shape necessary for successful extraction. The magnetic measurements, orbit calculations, and magnetic calculations that were used for adjusting this extraction system, which successfully extracted reduced energy protons with about 20% of the full energy current are described. Initial adjustments in the location and quantity of iron were made when magnetic measurements were performed using orbit calculations and phase-space plots based on the measured magnetic fields which were systematically altered until the phase-space plots indicated that the peeler-regenerator sections would produce extraction of protons with acceptable energy. During the final adjustments, using radiographic techniques to locate the proton beam in the extraction channel, alterations were made to various sections of the channel permitting it to accept the proton energy and entrance angle produced by the peeler-regenerator sections. (auth)

38079 EXTERNAL BEAM PERFORMANCE AT P.P.A. Kirchgessner, J. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 684-7(June 1967). (PPAD-613-E).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The proton beam extraction system which is now operational at the Princeton–Pennsylvania Accelerator is a resonant system operating on the $\nu = \frac{3}{4}$ radial betatron resonance. This method of extracting from a weak focusing synchrotron was first proposed and shown to work by Turrin et al. at Frascati, Italy. The system requires that the synchrotron magnet be turned to $\nu_r = \frac{3}{4}$ with a quadrupole magnetic field component and that an azimuthally varying second harmonic hexapole field be applied to drive the oscillations. When the oscillations have reached sufficient amplitude the particles enter the aperture of a septum magnet which bends them clear of the synchrotron. The beam is then steered and focused to the first target point in the External Beam building. (auth)

38080 ZGS EXTERNAL PROTON BEAM. Ratner, L. G.; de Parry, T.; Glowacki, A. M. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 688-92(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

Extraction methods, diagnostic equipment, and external beam lines are described. By the use of special targets and magnet field shapes, beams were extracted at energies between 4.0 and 13.4 GeV/c. Slow and fast extractions were accomplished with efficiencies greater than 30 percent and 50 percent, respectively. A parasitic beam was extracted with 20 percent efficiency. Extracted beams of up to 7×10^{11} protons/pulse with a 2.2 s repetition rate have been obtained for a neutrino experiment. To date, spill durations from 40 μs to 500 ms were achieved. A compact secondary emission detector having a very short radiation length was designed and operated. The multiple scattering introduced into the beam by this chamber is less than ½ milliradian. TV systems with scintillators and sodium iodide matrices were used to line up the beam. In the external beam line, three target stations were set up. The first is for a neutrino experiment, the second station for three experiments, and at the third station there are two experimental setups. (auth)

38081 NEW SCHEME OF BEAM EXTRACTION OF THE ARGONNE ZERO GRADIENT SYNCHROTRON. Martin, J. H.; Novey, T. B.; Suwa, S.; Yokosawa, A. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 693-5(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The new beam extraction system for fast extraction of protons from the Argonne Zero Gradient Synchrotron is described. Recently obtained results concerning its performance are also presented. (B.G.D.)

38082 RADIOFREQUENCY STIMULATION OF RESONANT SLOW EXTRACTION SYSTEMS. Robertson, D. S. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 696-701(June 1967). (BNL-11020).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The use of a deflecting cavity in a synchrotron for tightly bunching the beam with almost trivial deflection (typically, 20 μRad peak) is discussed. Topics include the bunching process, releasing of trapped particles, mechanism of trapping, and slow extraction process. (B.G.D.)

38083 SLOW EXTRACTION FROM FFAG ACCELERATORS. Hammer, C. L.; Haxby, R. O.; Tucker, R. (Iowa State Univ., Ames). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 702-4(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The results of earlier analytical calculations on the slow extraction of particles from an alternating gradient accelerator are applied to the special case of a fixed field alternating gradient accelerator. The extraction efficiency and rate of growth of the betatron oscillations are described. (auth)

38084 COMPLETION OF CONSTRUCTION AND INITIAL OPERATION OF THE SLAC ACCELERATOR. Neal, R. B. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 705-20(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The construction and initial operation of the SLAC accelerator are briefly discussed. Topics include a general description of the accelerator and experimental facilities, and initial operating results such as beam characteristics, klystrons, and economic and manpower statistics. (B.G.D.)

38085 GENERAL ATOMIC COUPLED ELECTRON LINEAR ACCELERATOR. Adcock, D. R.; Beyster, J. R.; Cole, J. L. (General Atomic Div., General Dynamics Corp., San Diego). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 721-8(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The General Atomic Linear Accelerator Facility consists of two L-band linear accelerators which can be operated independently or coupled together to form one machine. The first accelerator is a single section powered by a 20-MW klystron and is capable of operating over an energy range of 1.0 to 17 MeV. Peak currents of 16 A at 12 MeV and 40 ns pulse length have been obtained with the first Linac. The second Linac, which is built in line with the first machine, consists of three sections powered by one 10-MW and two 20-MW klystrons. The second Linac is capable of producing a 35-MeV electron beam with an intensity of 2 A at pulse length less than 0.1 μs. By rotating the injector of the second Linac it accepts the beam from the first machine, thereby creating a higher energy machine capable of delivering energies of up to 80 MeV. Other features of the facility include six independent irradiated cells, 15 target positions, and a high power positron converter; as well as monoenergetic gamma ray sources, high intensity neutron targets, and a single particle per pulse capability. In addition, a special cell contains the APFA-III accelerator-pulsed fast burst reactor, which is operated at a multiplication of 1000 to obtain neutron fluences of $10^{12}-10^{13}$ n/cm^2 in 5 μs. (auth)

38086 OPERATION AND PERFORMANCE OF A COMPACT, ISOCHRONOUS CYCLOTRON. Mulady, J. R.; Hendry, G. O.; Smith, C. G.; Tom, J. L.; Wells, D. K. (The Cyclotron Corp., Berkeley, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 729-32(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The apparent need for an inexpensive, reliable, and easy-to-operate cyclotron for isotope production, trace element analysis, and nuclear medicine has led to the design and construction of a 30-inch AVF cyclotron. This cyclotron has accelerated very stable beams of protons to 15 MeV, deuterons to 8 MeV, He^{3++} to 20 MeV, and alpha particles to 16 MeV. External beam currents in excess of 50 μA have been obtained for protons and deuterons. The required magnetic field for acceleration of all four particles is at-

tained in a three-sector configuration without the use of profile coils. Two 120° dees provide an energy gain of 100 keV per turn. The ion source, using ion-heated cathodes instead of the usual hot-filament, has allowed internal beams of more than one mA of protons and deuterons to be accelerated to full energy. A 30 μA external beam of 15-MeV protons has also been obtained by accelerating and stripping H^- ions. (auth)

38087 PERFORMANCE CHARACTERISTICS OF THE ZGS. Martin, R. L. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 740-2(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

The ZGS intensity was recently increased. The main factors involved were removing the limitations imposed by the coherent vertical instability and partial correction of tune variations occurring during acceleration. With the higher intensities we observe a growth in the radial size of the beam. These phenomena are discussed briefly. Slow extraction from the ZGS on a front porch field over a wide range of momenta was successful and the fast extraction efficiency has been increased to 50%. (auth)

38088 OPERATIONAL EXPERIENCE WITH NIMROD. Gray, D. A. (Rutherford High Energy Lab., Chilton, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 743-8(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

The recent experience with NIMROD operating at 1.5×10^{12} protons/pulse is discussed. The novel techniques for measuring radiation dose in the accelerator vacuum vessel are described with estimates of the radiation damage to components of the machine. A major re-shuffle of the main experimental area with two extracted beams is in progress and is described. Details are given of a new experimental hall for which full approval has been given. (auth)

38089 DESIGN OF A 15-MeV CW MICROTRON. Wintersteiner, P. P.; Edmonds, D. S. Jr. (Boston Univ.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 749-55 (June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

A 15 MeV microtron with 100% duty cycle is discussed. Topics included are high-energy orbits, injection and low energy orbits, injection semiorbit and first orbit, and first cavity traversal and subsequent orbits. (B.G.D.)

38090 FOUR-SECTOR RACETRACK MICROTRONS. Froelich, H. R.; Brannen, Eric (Univ. of Western Ontario, London). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 756-9(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

Racetrack geometries of the guide field are capable of freeing the microtron type of electron accelerator from its inherent limitations. Two completed racetrack microtrons of 2.5 and 6.3 MeV energy are described. A possible application of the design features of these accelerators to microtrons of up to 50 MeV is discussed. Preliminary results of a design study for a 200 MeV racetrack microtron are presented. (auth)

38091 A 4-MeV EXPERIMENTAL SEPARATED-ORBIT CYCLOTRON. Worsham, R. E.; Hudson, E. D.; Livingston, R. S.; Mann, J. E.; Martin, J. A.; Mosko, S. W.; Ziegler, N. F. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 760-3(June 1967). (ORNL-P-3003).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

A small experimental Separated-Orbit Cyclotron is being built to provide experience in the design and operation of this new type of accelerator. It will permit examination of the sensitivity of the SOC design to methods of construction and to errors in alignment. Some features are variable so that the flexibility of this class of machines for the acceleration of various particles and the applicability to high beam intensities can be evaluated. (auth)

38092 NEVIS SYNCHROCYCLOTRON IMPROVEMENT PROGRAM. Cohen, R. (Columbia Univ., New York); Baron, E.; Rainwater, J.; Mobley, R.; Ohnuma, S. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 764-6(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

The improvement program for the Nevis synchrocyclotron is briefly discussed. Topics include space charge considerations in beam currents achieved and one-fifth scale model magnet. (B.G.D.)

38093 ELECTRON BEAMS FROM 10^{11} TO 10^{12} WATT PULSED ACCELERATORS. Link, W. T. (Physics International Co., San Leandro, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 777-81(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

Current research on the behavior of electron beams in the 10^5-ampere range is discussed. Topics include description of pulsed accelerators, diagnostic equipment, behavior of electron beams as a function of the gas pressure in the beam chamber, image forces in a conductor, and radial cross sections of electron beams. (B.G.D.)

38094 GENERATION AND DIAGNOSIS OF PULSED RELATIVISTIC ELECTRON BEAMS ABOVE 10^{10} WATTS. Graybill, S. E.; Nablo, S. V. (Ion Physics Corp., Burlington, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 782-8(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

A review of the several approaches to the generation of intense electron streams in the megavolt energy regime is presented. The techniques used in the diagnosis of the 30,000 ampere, 3 MeV beam from a gas insulated coaxial system with a characteristic pulse length of 25 nanoseconds are discussed. The general features of such a stream drifting under self-focused conditions are presented and the results compared with the theory of such an idealized beam. The results of work conducted with cathode arrays of varying geometry are discussed. In particular, the dynamics of 20,000 ampere streams at 2 MeV, from arrays with $1 \leq n \leq 4$, are presented. Based on these data, a prognosis is made for the limitations of future high peak power electron accelerators at energies in the 10 MeV range. (auth)

38095 INTENSE, NANOSECOND ELECTRON BEAMS. Charbonnier, F. M.; Barbour, J. P.; Brewster, J. L.; Dyke, W. P.; Grundhauser, F. J. (Field Emission Corp., McMinnville, Oreg.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 789-93(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

Pulsed radiation sources of higher intensity and shorter duration are desired to broaden the scope of experimental studies of radiation-induced phenomena. For this purpose, a family of generators has been developed which can produce intense pulsed beams of electrons. The highly reproducible beam is extracted from the accelerating tube through a thin window and can be injected readily into other experimental apparatus. Available pulse durations range from 3 to 50 nanoseconds. The maximum electron energy can be adjusted continuously from 150 to 600 keV, or from 500 keV to 2 MeV, depending on the specific generator. Available peak beam currents range from 1,000 to 10,000 amperes, and the electron output can be varied from 10^{12} to 2×10^{15} electrons per pulse. When desired, the output beam can be concentrated magnetically to energy densities in excess of 100 cal/cm^2, creating shock waves and permitting study of materials under intense transient stress. The basic design concepts, and diagnostic techniques developed or adapted for reliable measurement of the beam characteristics, will be discussed. (auth)

38096 VACUUM CHAMBER SYSTEM FOR HIGH RADIATION ENVIRONMENT. Hanson, Willard B.; Moenich, John S.; Rohrmayer, Alfred (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 804-8 (June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

As the radiation environment in the proximity of high energy beams becomes an ever increasing problem, the need for radiation resistant vacuum chambers and seals of inorganic materials has become apparent. The long range plans for the ZGS have been in this direction. A three-year development program has resulted in a design which will withstand radiation levels several orders of magnitude greater than at present. Such a chamber will be installed early in 1968, five years after original machine startup. (auth)

38097 EXPERIENCE WITH METAL AND EPOXY VACUUM CHAMBERS AND THE DEVELOPMENT OF ALUMINA CERAMIC VACUUM CHAMBERS AT THE CEA. Hay, R. D.; Winick, H. (Cambridge Electron Accelerator, Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 815-20 (June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

The performance of stainless steel epoxy-fiber glass coated vacuum chambers at the Cambridge Electron Accelerator is reviewed

with special attention to radiation resistance and ultimate vacuum capability. In order to increase chamber life for more reliable synchrotron operation an aluminum oxide ceramic and metal design was developed. (auth)

38098 VACUUM BEHAVIOR OF VARIOUS MATERIALS WITH RADIATION AND HEAT. Gould, C. L.; Schuchman, J. S. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 821-30(June 1967). (BNL-11143).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

A number of vacuum chamber materials were investigated as to their suitability before and after radiation to 5×10^9 RADS and also at temperatures of 120°C. (B.G.D.)

38099 FAST-ACTING VALVE. Moenich, John S. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 838-42(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

In areas of the Zero Gradient Synchrotron (ZGS) accelerator where high energy proton beams or other nuclear particles are extracted from the interior of the synchrotron into experimental areas, thin mylar or aluminum windows are used to minimize energy losses. Rupture of these windows (as large as nine inches in diameter) could cause considerable damage. A 9-inch, fast-closing valve has been designed and a prototype has been built and tested. The valve can operate in vacuum or at atmosphere. Closure of the valve requires no circuits, signals, or mechanical actuators, but rather is activated by the energy of the inrushing gas itself. An electrically triggered clutch arrangement can be incorporated for mechanical closing, if so desired, with no interference when the fast mode of closure is necessary. The results of the fast mode of closure indicate closing times of 17 to 30 ms. Blowby, before closure of the valve is completed, is approximately 2.5 ft^3 of air (at one atmosphere). With such a valve, the entire ring vacuum system will not reach pressures greater than 300 microns (0.3 mm Hg), should a 9-inch diameter window rupture. (auth)

38100 ENGINEERING OF ACCELERATOR FACILITIES. Gordon, Hayden S. (William M. Brobeck and Associates, Berkeley, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 843-8(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The engineering of an accelerator facility requires completion of a logical series of tasks. After confirming a need or justification, a feasibility study must be made. At this point the engineering work is usually separated into two parts—one for the accelerator proper and its associated research equipment and the other for its housing and services. For the accelerator, conceptual design leads to establishment of financial and time budgets. Systems design permits cost estimates and schedules to be made. Detail design permits bids for construction and installation to be obtained. Procurement and installation services finally lead to test and start-up. For the building, site selection and study lead to one or more conceptual designs. Preliminary design permits tentative budgets and schedules to be set. Final design leads to building contracts, course of construction services and final acceptance. The engineering costs incurred in carrying an accelerator concept through from feasibility study to an operating machine will run from a minimum of about ten percent to a maximum of about thirty-seven percent. For the accelerator site and buildings the corresponding limits are ten and thirteen percent. Thus, for an accelerator facility where the construction costs are divided approximately equally between the machine and its housing, the total engineering costs will be between ten and twenty percent of the construction costs. (auth)

38101 OPERATION OF ACCELERATORS DIRECTLY OFF THE UTILITY SYSTEM. Rohrmayer, Alfred (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 849-53(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The operation of accelerators directly off the utility line is primarily restricted by the voltage fluctuation it causes on the utility system. To limit the voltage fluctuation, it will be necessary to design equipment and circuitry to reduce the MVARs during flat-topping and at the beginning of inversion. The advantages gained with the elimination of motor generator (M-G) sets will outweigh any disadvantages of more complicated equipment and possible operating restrictions. Based on a one second acceleration time, restricted MVAR during flat-topping and a range of 0.5-1% voltage fluctuation, the stored energy in the ring magnet in MJ may be between 0.25 and 0.5% of the short circuit capacity (SCC) of the system at the point the accelerator is interconnected. Action of the generator voltage regulators will reduce the calculated voltage flicker or the required SCC. There are many systems that are large enough to permit direct operation of medium sized accelerators or stand-by operation of large accelerators at reduced capacity. Large accelerators will require large utility systems. (auth)

38102 PHYSICAL DESIGN OF A 200-MeV LINAC FACILITY. Grand, P. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 860-6(June 1967). (BNL-11146).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The physical design of the 200-MeV linac facility for the Brookhaven National Laboratory AGS is briefly discussed. Topics include parameters, buildings, and the linac itself. (B.G.D.)

38103 CONVERSION OF AGS RING TO MODULAR CONSTRUCTION. Hoober, D.; Buchanan, V. J. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 867-71 (June 1967). (BNL-11122).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The conversion of the AGS to modular construction to permit rapid and safe handling is discussed. The conversion program will include the magnets, cooling system, the buses that supply the power, lifting rigs for the magnets, and the vacuum chamber. (B.G.D.)

38104 MODULAR ACCELERATOR DESIGN. Tom, J. L. (The Cyclotron Corp., Berkeley, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 872-5(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

A modular approach to the design of accelerators is presented. A 30-inch AVF cyclotron has been built on this approach where all major assemblies are self-contained modules. Each unit, such as the magnet, rf system, vacuum system, ion source, and extraction system, was independently assembled, operated, and tested. Such an approach enabled the accelerator to be so flexible that systems of different designs, such as two-dee or single-dee acceleration, could be interchanged without modifying other parts of the machine. The features which permitted this approach on the now operational 30-inch cyclotron are presented, along with suggestions on how a modular design concept might well be used on larger accelerators. (auth)

38105 VARIABLE ENERGY CYCLOTRON. McFarlin, W. A. (Texas A and M Univ., College Station); Goerz, D. J. Jr.; Dikinis, D. V. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 876-80(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The performance specifications and the various systems of the Texas A & M Variable Energy Cyclotron are discussed. Topics include the magnet system, resonant system, ion sources, vacuum system, control systems, power supplies, rf frequency regulating system, positioning systems, and instrumentation. (B.G.D.)

38106 MARYLAND UNIVERSITY SECTORED ISOCHRONOUS CYCLOTRON MUSIC. Leboutet, H. (Compagnie Generale de TSF, Orsay, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 881-6(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

This paper describes the main features of the Music cyclotron machine as they appear after completion of the basic studies and initiation of the procurement of the components. Music is a variable energy cyclotron of nominal energy 100 MeV protons using a four sector magnet and two 90° dees connected to two panel tuned rf cavities. The conventional ion source will be mounted through a hole in the frame. Axial injection from an external source is also envisaged. Extraction will use electrostatic and electromagnetic deflectors. The cyclotron general arrangement is similar to the Grenoble machine. It was designed to accelerate protons up to at least 100 MeV, deuterons up to 70 MeV, alpha particles up to 140 MeV and ^3He up to 190 MeV. In order to ensure the 100 MeV proton value, the magnetic field was designed for 114 MeV and it turns out how that with the help of the installed flutter coils (hill and valley coils) somewhat higher proton energies could be made stable up to extraction radius. (auth)

38107 COMPUTER-AIDED RECORDING OF CONTROL WIRING. Featherstone, Robert P.; Mayer, William J. (Univ. of Minnesota, Minneapolis). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 898-902(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

Most particle accelerators have extensive networks of control wiring. The usual stream of minor modifications requires hundreds of control wires to be added, deleted, or changed in function every few months. Conventional terminal and cable record books and wiring diagrams are difficult to keep up to date and often are cumbersome to use. Improved computer-aided techniques were devised for organizing information about a control wiring network into compact forms convenient both for trouble-shooting and for new design work. Additions and deletions require only a single data card per wire. The computer prints out a pattern of interconnections for each circuit, adds information on circuit functions, and finds and marks such probable errors as dead-end wires and redundant circuit paths. The computer-aided system has been in use for nearly two years at the University of Minnesota proton linear accelerator, which has a control wiring network containing about 10,000 wires. A complete set of record books can be worked out in about 18 minutes on a Control Data 1604 computer. Trouble-shooting, identification of wiring errors, and design of system additions all have benefited from the speed, convenience, and accuracy of the computer-aided system. (auth)

38108 PRECISION ALIGNMENT OF A LARGE BEAM TRANSPORT SYSTEM. Herrmannsfeldt, W. B.; Anderson, M.; Connell, D.; Hooley, B.; Niforopulos, J. G.; O'Keefe, R. J.; Seppi, E. J.; Voss, J. M.; Weidner, H. A.; Witthaus, J. K. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 903-7(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

The beam criteria for the SLAC beam switchyard and the effect of these criteria upon alignment tolerances and placement of components in the switchyard are discussed. The methods developed in the shop and in the field for meeting the stringent alignment tolerances are also covered. (auth)

38109 HANDLING HIGH POWER ELECTRON BEAMS. Penner, S. (National Bureau of Standards, Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 908-17(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

In recent years accelerators have been designed and built which produce beams of extremely high power, current, and charge-per-pulse. The handling of these beams presents a number of difficult problems. Among these problems are: removal of large heat flux, fatigue failure of components due to pulsed nature of the beam, radiation damage of materials, corrosion, residual radioactivity, and chemical effects such as radiolysis of water and production of noxious gases. Consideration of these problems strongly influences the overall design of beam handling systems, as well as the design of specific components. Examples of the problems encountered and the solutions adopted in various electron accelerator laboratories will be discussed. (auth)

38110 DESIGN, CONSTRUCTION, AND EARLY OPERATING EXPERIENCE OF THE SLAC BEAM SWITCHYARD AND EXPERIMENTAL AREAS. Weidner, H.; Seppi, E. J.; Harris, J. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 918-22(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

A description of the overall design and construction of the SLAC beam switchyard and experimental areas is presented. The electron optics and transport components of the switchyard are described. The high-intensity beams transported by this system present special problems requiring design for radiation resistance, remote-precise location, quick removal, and resistance to corrosive environments. These problems and their solution are discussed. The SLAC research yard and its present experimental facilities are discussed. Finally, a design evaluation and summary of early tests and operation experience in this area are presented. (auth)

38111 BEAM DUMPS, ENERGY SLITS, AND COLLIMATORS AT SLAC: THEIR FINAL VERSIONS AND FIRST PERFORMANCE DATA. Walz, D. R.; Lucas, L. R.; Weidner, H. A.; Vetterlein, R. J.; Seppi, E. J. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 923-7 (June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

The final as-built versions of high power beam dumps, slits, and collimators, which are capable of absorbing 1 to 2 MW electron beams continuously are discussed. Some of the important design features are illustrated with pictures. Experimental results of testing a beam dump window and a small module prototype are added. The remote control and read-out system of variable aperture slits and collimators is emphasized and performance data are given. Then the criteria for safely achieving high beam power dissipation (heat transfer rates, nucleate and film boiling conditions, thermal stress, thermal shock and fatigue) are reviewed. Solutions to problems encountered in operating equipment in a corrosive, high radiation area where organic lubricants fail are presented. Finally, radiolysis of water and evolution of free hydrogen are dealt with. Experimental results from high power electron beams are reported. Disposal of hydrogen and radioactive gases evolving in surge tanks is discussed and solutions are proposed. (auth)

38112 HIGH CURRENT TARGET FOR POSITIVE ION ACCELERATORS. Seiler, R. F. (Boeing Co., Seattle); Cleland, M. R.; Wegner, H. E. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 943-4(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

Target development work has led to a design which has been tested with beam power densities near 10 kW/cm^2. Use of this design with hydrogen isotopes for targets provides stable long-lived neutron sources. (auth)

38113 HIGH-POWER WINDOWLESS GAS TARGET. Lidsky, L. M.; Colombant, D. (Massachusetts Inst. of Tech., Cambridge). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 945-9(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

A high density free-jet has a combination of properties that lend themselves well to the design of a high efficiency, high power beam target. One possible application of a free-jet target is a 14.2-MeV neutron source with 10^{14}/cm^2 sec surface flux. (auth)

38114 HIGH POWER POSITRON CONVERSION TARGET FOR AN ELECTRON LINAC. Parkins, M. F. (Vickers Ltd., Swindon, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 950-4(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

The target consists of a series of annular discs which, when held concentric with the beam, allow the beam to pass unobstructed through the central holes but which, when nutated intercept it to produce electron-positron pairs. Some of the positrons are focused into the next accelerator section by a magnetic lens, and, a solenoidal field throughout the remainder of the accelerator which is phased for positron accelerator maintains the beam diameter. A novel design feature is that the same water is used to nutate the target via turbine blades and cool the target. Nutation permits bellows to make the vacuum joints so avoiding the use of moving vacuum seals which would be necessary with a rotating target. Target heat load is discussed with particular reference to the requirement for the Glasgow accelerator where the maximum electron beam energy is 110 MeV and the maximum mean power 30 kW. The principle of nutation and the control system are described, and bellows fatigue, operational tests and safety systems are discussed. (auth)

38115 SECONDARY BEAM TARGETRY DEVELOPMENTS. Marcks, Donald F.; Wehrle, Robert B. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 955-9(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

Two recently developed target manipulators have increased the versatility of remote multitargeting in the production of secondary particles from within the Argonne Zero Gradient Synchrotron (ZGS). The Mark II manipulator is constructed in modular form to facilitate assembly in one of four arm-swing configurations. This allows new coverage patterns for the three to four manipulator combinations that can multitarget on a single synchrotron pulse. It also provides for quick, accurate target changes by replacement of a complete presurveyed arm and target assembly. A current pulsed coil, reacting with the guide field, thrusts the target of the Mark IV manipulator upwards from the bottom of the beam chamber. The Mark IV compact design permits close targeting positions between manipulators. The manipulator provides distinct target movements in each of the three coordinate axes (X, Y, and Z), as well as rotation in the XZ plane. This enhances automatic target positioning control. An exact replica of the 32- × 70-in. meson targeting area has been used for positional presurveys of meson targets and for the calibration of their positional readout systems. This use has greatly reduced radiation exposure to personnel and contributed substantially towards a 50% reduction in the ZGS maintenance time. (auth)

38116 RESIDUAL RADIATION STUDIES FOR MEDIUM ENERGY PROTON ACCELERATORS. Fulmer, C. B.; Williams, I. R.; Ball, J. B. (Oak Ridge National Lab., Tenn.). IEEE

(Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 977-9 (June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

Residual radiation levels to be encountered in medium energy proton accelerators at high beam intensity are evaluated. Excitation function data were obtained for the production of the most probable radionuclides. A computer code that takes into account the change of cross sections as the beam penetrates the target material was used to compute residual radiation dose rates for carbon, aluminum, iron, and copper as functions of bombardment time and cooling time. (auth)

38117 INDUCED RADIOACTIVITY AND RELATED MEASUREMENTS IN A 3 GeV HIGH CURRENT PROTON SYNCHROTRON. Awschalom, M.; Larsen, F. L.; Schimmerling, W. (Princeton Univ., N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 980-4(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

Some of the experience gained while working with and around the radioactivated components of a high current 3-GeV proton synchrotron is briefly presented and discussed. The topics presented are: air radioactivation in the synchrotron room, correlation between measured neutron fluxes through the synchrotron magnets and remanent radioactivity, transferable radioactivity, radiation exposure to personnel, and radioactivation of machine components and shielding. (auth)

38118 SURVEY OF RADIATION DOSES AND INDUCED ACTIVITY AT THE ZGS FROM SEPTEMBER 1965 TO SEPTEMBER 1966. Lucks, Herbert; Marcowitz, Stewart M. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 985-9(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

In order to know the distribution of radiation around an accelerator quantitatively, a program for monitoring the distribution of induced activity and total radiation dose in the Zero Gradient Synchrotron Ring Building was started in 1965. An attempt to compile the data to see if definite patterns exist, extract useful calculation constants, and to extrapolate the total doses received by components since the startup of the ZGS is discussed. Some of the relationships which were examined are: the distribution of dose received by components of the ZGS per operating hour or per circulating proton, the distribution of induced activity, and the ratio of induced activity to average dose at the same location. (B.G.D.)

38119 RADIOACTIVITY PRODUCED BY A LINAC. Wyckoff, James M. (National Bureau of Standards, Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 990-6(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

Over 40 different materials have been irradiated in the 100 MeV bremsstrahlung beam from the NBS linac. The major contributions to the gamma ray spectrum from the radioactive products have been measured using a Ge(Li) detector. Measurements have been made of gamma rays of concern in the 30 minute to 30 day time interval but this includes in some cases gamma rays from nuclides with half lives as long as 30 years. Eighteen of the samples were pure materials and 25 were commonly used structural, shielding, electrical and mechanical components. In several important cases nuclides produced by multiple particle emission dominate the picture. (auth)

38120 AUTOMATICALLY AND REMOTELY WELDED AND REMOVABLE WELD FLANGE VACUUM JOINT. Voss, John M. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1004-9(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The development, testing, and evaluation of a welded vacuum flange, capable of being automatically welded are then removed and rewelded at least 4 times are discussed. (auth)

38121 AGS MAGNET ENCLOSURE BEAM SPILL AND PERSONNEL SAFETY MONITOR. Distenfeld, C.; Colvett, R.; Lamplough, J. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1010-15(June 1967). (BNL-11170).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

A synchrotron ring radiation monitoring system was constructed that serves as a spill monitor, personnel safety monitor, and radiation dosimeter for degradable machine components. One-third of the 30 detectors ultimately expected have been in service for about six months with full realization of all design concepts. (auth)

38122 NBS LINAC MASTER CONTROL AND PERSONNEL PROTECTION SYSTEM. Spokas, O. E. (National Bureau of Standards, Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1016-21(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The operation of the NBS linear accelerator and its beam handling equipment has been integrated with personnel and equipment protection safeguards and with the occupancy requirements of the linac complex. A mode switch is used to select beam direction and experimental area, and to program the requirements for personnel protection interlocks, beam handling system conditions, building mechanical services, experimental area services, and linac operation. The system includes visual and audible devices to indicate degree of readiness, hazards, faults, interlock information, zone of operation and emergency situations. A forced inspection of potentially dangerous zones, programmed cued taped warning announcements, key interlocks, and flexibility are built-in features. It offers the capability of providing maximum protection to personnel against environmental radiation hazards, and allows utilization of a maximum of laboratory space for varied beam conditions. (auth)

38123 CONTROL SYSTEM FOR THE STANFORD LINEAR ACCELERATOR. Mallory, K. B. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1022-9(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The control system for the Stanford linear accelerator which was shaped by influences such as length of accelerator, noise environment, multiple beam concept, and desirability of single-operator or computer control is discussed. (auth)

38124 MULTIPLEX CONTROL SYSTEM FOR THE CORNELL 10-GeV SYNCHROTRON. Littauer, Raphael; Pfeffer, Howard (Cornell Univ., Ithaca, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1050-2(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The outlines of a time-sharing multiplex control system for the Cornell 10-GeV electron synchrotron were presented at the First National Particle Accelerator Conference, March 1965. The synchrotron is now nearing completion; injection studies involving more than half the guide-field ring were carried out in 1966. At that time, the multiplex control system was working for most of the needed parameters: we report below on the results of this operating experience. An outline of the steps which are being taken to use a computer for supervision and control of many of the accelerator components is presented. (auth)

38125 BEAM MANIPULATION EQUIPMENT AT THE ZERO GRADIENT SYNCHROTRON. Trendler, R. C. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1053-6(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The evolution of working accelerators invariably requires increasing flexible beam manipulation to fulfill the demands of high energy physics. A hybrid digital-analog system that provides intricate beam manipulation programs for use with the ZGS is described. The system requirements, design philosophy, equipment developed to fulfill these requirements, and present performance of the equipment are discussed. (auth)

38126 ON-LINE COMPUTER PREPARATION OF TUNE PROFILES OF THE ZERO GRADIENT SYNCHROTRON. Knott, Martin J.; Nordby, David H.; Swoboda, Carl A. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1057-60(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The data acquisition, handling, and presentation capabilities of the Zero Gradient Synchrotron control computer, which are used to present operators and machine researchers with tune profiles measured under injection conditions, are discussed. (B.G.D.)

38127 INSTRUMENTATION AND ELECTRONICS FOR THE SLAC BEAM SWITCHYARD. Scholl, R.; Coombes, R.; Hall, J.; Neet, D.; Olsen, D. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1061-5(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1-3, 1967. See CONF-670307.

The electronics and instrumentation for the SLAC beam switchyard which is a large Y-shaped area containing magnets, slits, collimators, and instruments for beam observation, are described. The purpose of the switchyard is to momentum analyze the beam

and determine energy spread at the exit, to transport the beam to the experiment under selected focusing conditions, and to separate the interlaced beams coming from the accelerator. (B.G.D.)

38128 SLAC BEAM SWITCHYARD CONTROL COMPUTER. Howry, S. K.; Scholl, R.; Seppi, E. J.; Hu, M.; Neet, D. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1066-70(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

A computer system was developed at SLAC in the beam switchyard for on-line beam transport control. The system consists of an SDS 925 computer and various specially designed interface devices. The system scans and records changes in interlocks and status signals; sets up, monitors, and maintains magnet currents and controls collimator and slit apertures. In addition to standard card and teletype input–output, the system has special panels for operator control of magnet currents and slit and collimator settings. A link to another computer provides for remote information access and control for experimenters. An important feature of the system is the operator oriented language which is provided for operator/computer interaction. The language is arranged so that an inadvertent action of the operator cannot adversely affect the computer program. A single computer instruction can vary a group of magnets simulteneously to change the beam energy while maintaining a given beam focusing condition. A fine-tune control has been provided so that the current in an arbitrary group can be controlled by a single switch. The operator can write instructions in the language which are synchronized in time to $\frac{1}{360}$ of a second, and/or repeated at prescribed time intervals. (auth)

38129 SOLID STATE CONTROL AND LOGIC SYSTEM FOR BEAM HANDLING AND ION OPTICS EXTERNAL TO THE NRL ISOCHRONOUS CYCLOTRON. Gordon, S. E.; Eisele, J. A. (Naval Research Lab., Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1082-6(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

As the capability of isochronous cyclotrons increases, and the requirements of the experimentalist become more sophisticated, the problems of beam handling and transport become more complex and demanding. At the NRL Isochronous Cyclotron Facility, these problems have been solved by using solid state OR, AND, NOR, and NAND logic wherever possible. Initial beam path selection is through a select-safe circuit which allows only one of 15 beam paths to be energized. After selection, it cannot be accidentally shut down. Diode, diode-transistor, and transistor–resistor logic have been used for all beam handling and transport devices, and for light and readout switching. These circuits use diode matrices to control voltage, resistor matrices to mix currents, and transistors as switches. Defective lamps are determined by a circuit which allows all lights in the control room to be tested simultaneously by pushing one button. Plug-in boards and relays, quick change indicators, 90-pin connectors, and miniature terminal strips are used to facilitate trouble shooting and programming. A portable mock-up of the control console was produced for circuit test purposes, for on site operation of a beam handling device, and as a training device for new operators. (auth)

38130 CONTROL OF BETATRON OSCILLATIONS IN A CYCLOTRON BY THE USE OF AN ON-LINE COMPUTER. Loesel, M. E.; Schatz, G.; Schweickert, H. (Kernforschungszentrum, Karlsruhe, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1087-90(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

A system is described which is used to control radial betatron oscillations in the Karlsruhe AVF Cyclotron. The output of a radial current density target is digitized and fed into the memory of a CDC 3100 on-line computer. As different orbits are separated up to extraction radius in the Karlsruhe cyclotron they can be identified by a computer program. Their radii can either be displayed on an oscilloscope screen or used for further calculations in order to obtain information on necessary corrections of the magnetic field. (auth)

38131 SLAC LONG ION CHAMBER SYSTEM FOR MACHINE PROTECTION. Fishman, Max; Reagan, Daryl (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1096-8(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

To protect the Stanford 3 km accelerator from damage caused by its own electron beam, a single ion chamber has been installed, which runs the whole length of the accelerator. The pulse train from the ion chamber is displayed on an oscilloscope, giving a representation of beam power loss along the machine as a function of distance from the injector. It also operates a system that shuts off the electron beam within 1 ms whenever the signal level exceeds a preset value. (auth)

38132 HIGH CURRENT BEAM SCANNER. Wegner, H. E.; Feigenbaum, I. L. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1099-1105(June 1967). (BNL-11133).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

It was shown that a commercially availab'e scanner can be modified by the addition of an axial marker generator and water-cooled tubes in place of wires so that it can routinely scan high-current accelerator beams up to beam power densities of at least 35 kW/cm^2. The versatility of the scanner was demonstrated by its use with several different accelerators. In all cases, the installation of the scanner involved only simple adaptation to an existing beam pipe and the device was usually in place and functioning properly in less than an hour's time. Long term reliability studies were not made to date, however, the first tube installed failed from apparent radiation damage or sputtering in approximately 20,000 μA hours of all types of test beams. Further measurements with different tube materials will determine which material is best for different kinds of beams and will be reported elsewhere. (auth)

38133 LOW FREQUENCY BEAM POSITION MONITOR. Johnston, L.; Faust, J.; Pierce, W.; Stangenes, M. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1106-10(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

The beam position monitor described here is inductively driven by the 1.7-microsecond pulse envelope of a relativistic electron beam. Its principal virtues seem to be its simplicity, its inherently fixed zero position, and its adaptability to wide apertures. In the form presented, it has a 3.5-inch clear aperture; its minimum sensible beam current × beam displacement is about 2×10^{-4} ampere-millimeters; its ultimate spatial resolution is 0.1 millimeter. (auth)

38134 BEAM MONITORS BASED ON LIGHT OBSERVATION FOR THE BEAM SWITCHYARD ON THE STANFORD TWO-MILE LINEAR ACCELERATOR. Coombes, R. W.; Neet, D. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1111-15(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

Three monitors and the associated optical system used to observe the profile of the high-power electron beam in the switchyard of the two-mile linear accelerator are discussed. One device is based on the observation of synchrotron light emitted by the beam when deflected in the analyzing magnets. The second type uses the Cherenkov light produced in a gas cell which is inserted into the beam path when needed. The third type uses conventional zinc sulfide screens with a mechanism for replacing a screen which has become inactive, with a new screen. Reflective optics systems and closed circuit television are used to transmit the images of the beam spots to TV monitors in the control room. (auth)

38135 MICROWAVE BEAM POSITION MONITORS AT SLAC. Farinholt, E. V.; Farkas, Z. D.; Hogg, H. A. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1127-31(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

The design and performance of three types of nonintercepting microwave beam position monitors are described. The monitors locate the transverse centroid of the bunched beam. Monitors of the first two types each consist of two orthogonal position-sensing cavities and one reference cavity. The microwave signals induced by the beam in these cavities are combined in two phase bridges and linearly detected. The video signals are normalized with respect to beam current and transmitted to two control buildings where they are displayed. Thirty-three monitors along the linear accelerator have 0.8-inch apertures, and six special monitors at the end of the machine have 2.0-inch apertures. A third type of monitor has been installed in one experimental area. Waveguide couplers on a 3-inch diameter beam drift tube feed signals to a phase bridge. The bridge sum and difference signals are amplified, detected, and differentially displayed on an oscilloscope. The device can detect 0.004-inch changes in position of a 0.01 mA beam with a response time of 50 ns. (auth)

38136 MEASUREMENT OF CHARGE EMISSION FROM TARGETS AS A MEANS OF BURST INTENSITY AND BEAM INTENSITY MONITORING. Budal, K. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1132-7(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

Internal and external operational targets for the CERN Proton Synchrotron have been electrically insulated and the charge emission from the targets measured as a means of burst intensity monitoring. Charge emission from plates placed in ejected beams have been used for beam intensity monitoring. The measurements presented concern linearity, saturation and reproducibility tests, and investigations of the various parameters influencing the signal level. The main contribution to the signal comes from δ-rays which escape from the target. Theoretical results are presented and compared with experimental results. (auth)

38137 PLUNGING FARADAY CUP SYSTEM AND A SLIT SYSTEM FOR USE IN THE ZERO GRADIENT SYNCHROTRON SHORT STRAIGHT SECTIONS. Batch, R. V.; Cassidy, T. D.; DeLuca, W. H. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1138-42(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

Each short straight section of the Zero Gradient Synchrotron (ZGS) contains mechanisms for positioning three beam detectors. The mechanisms are noteworthy because of their unique target fast stroke length adjustment capabilities. One detector consists of a solid plate containing a long, horizontal slit. Plate position is vertically adjustable over a wide range. Beam currents to the plate flow through a coaxial cable to a signal detecting circuit. The second detector is a vertical square bar that is plunged upward. The plunge distance and horizontal position of the bar are continuously adjustable over the whole aperture. A coaxial cable connected to the bar carries beam currents to a signal detecting circuit. The third device is a vertical segmented assembly of linearly arranged detectors that can be plunged downward. The plunge distance and the horizontal position of the segmented assembly are continuously adjustable over the whole aperture. Each insulated segment is connected to resistor networks that provide voltages proportional to the total current to the segments and to the weighted function of the current to each segment. The vertical position of the beam can be derived from these voltages. (auth)

38138 DIAGNOSTIC SYSTEM FOR OPTIMIZATION OF THE EXTERNAL BEAM QUALITY OF THE OAK RIDGE ISOCHRONOUS CYCLOTRON. Lord, R. S.; Mallory, M. L.; Stevens, S. S.; Duelli, B. L.; Newman, E.; Smith, W. R. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1151-4(June 1967). (ORNL-P-2998).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

The parameters of the external beam that are of prime importance to the experimenter are the emittance, energy spread, intensity of analyzed beam, and time structure. Diagnostic equipment was developed for routine measurement and optimization of these parameters. (auth)

38139 MEASUREMENT AND MONITORING OF THE EJECTED PROTON BEAM 58 OF THE CERN PROTON SYNCHROTRON. Agoritsas, V.; Battisti, S.; Bovet, C.; Dekkers, D.; Henny, L.; Hoffmann, L.; Reich, K. H.; Riezler, W.; Robert, J.; van Rooy, M. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1155-60(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

Instantaneous proton flux densities of the order of 10^{11} to 10^{20} p cm^{-2} s^{-1} have to be measured and monitored in this ejected proton beam, the mean fluxes being about 10^{10} to 10^{12} p s^{-1}, the burst durations ranging from about 10^{-3} to 10^{-1} s and the beam cross sections from 10^{-1} to several cm^2. These fluxes are much higher than those encountered previously in secondary beams but not yet high enough for macroscopic methods to be comfortably usable. Another difficulty results from the increased radiation damage. For the observation of the particle distribution in space and time, fluorescent screens and television, special nuclear emulsions and plastic counters are used; while current transformers and a secondary emission chamber serve for intensity measurements during normal operation. The choice of these detectors and monitors, their characteristics, their calibration, and experience with operation since Autumn 1965, are discussed. (auth)

38140 CERN STORAGE RING PROJECT. Johnsen, Kjell (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1161-8(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

CERN has carried out over a number of years a detailed study on the possibility of adding a set of Intersecting Storage Rings (ISR) to its 28 GeV Proton Synchrotron. The plans presented by CERN were accepted by the CERN Council at its meeting in June 1965 and the necessary funds for the construction were allocated in December of the same year. The ISR will consist of two concentric magnet rings of about 150 m mean radius. The two rings are slightly distorted so as to cross each other at 8 points, around which the colliding beam experimentation will take place. With about 20 A of stacked protons in each ring, the interaction rate will be about 1.5×10^5 interactions/sec in each of the crossing points. The construction has started and the lecture will give a description of the project and its present status. It is hoped that the running-in of the facility will start in 1971. (auth)

38141 STORAGE RINGS FOR ELECTRONS AND POSITRONS. Mills, F. E. (Midwestern Universities Research Association, Stoughton, Wis.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1169-73(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

Storage rings for electrons and positrons provide a powerful tool for investigation of a variety of high energy processes. The development of storage rings has relied heavily on advanced accelerator technology. Many problems such as beam instability have arisen but acceptable solutions to these problems appear to have been found. Presently contemplated storage ring projects include plans for storage rings for energies as high as 5 BeV. (auth)

38142 MICROWAVE ELECTRON ACCELERATORS IN THE MEDIUM ENERGY RANGE. Nunan, C. S. (Varian Associates, Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1174-85(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

Microwave electron accelerators in the 3 MeV to 1 GeV range are being developed and produced for a variety of applications. Clinically useful x-ray, electron, neutron and pion beams can be produced for cancer therapy. Processing machines can provide electron and x-ray beams for the chemical, plastics, and food industries. CW and high duty cycle accelerators are being studied and developed for research in nuclear physics. Low and medium duty cycle accelerators are being built for storage ring and synchrotron injection, neutron spectroscopy, biology and a variety of other research uses. Current design concepts for these and other applications are described. (auth)

38143 DESIGN STUDY ON 1000-GeV CYBERNETIC ACCELERATOR AND 1-GeV MODEL. Vasil'ev, A. A. (Radiotechnical Inst., Moscow). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1186-9(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

The general characteristics of the 100-GeV cybernetic accelerator and its 1-GeV model are presented. The economic and technological feasibility of building the 1000-GeV accelerator is discussed. (B.G.D.)

38144 SERPUKHOV 70-GeV ACCELERATOR. Yuan, Luke C. L.; Myae, E. A. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1190-1(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

A general review of the present status of the Serpukhov 70-GeV accelerator is presented as well as a compilation of the basic parameters of the machine. (B.G.D.)

38145 PRESENT DAY ELECTRON SYNCHROTRONS FOR ENERGIES ABOVE 3 GeV. McDaniel, B. D. (Cornell Univ., Ithaca, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: 1197-1203(June 1967).

From National Particle Accelerator Conference, Washington, D. C., March 1–3, 1967. See CONF-670307.

The characteristics of five accelerators designed for energies exceeding 3 GeV are discussed. The features of the Cornell 10 GeV machine are described in some detail. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 36073 and 37540.

38146 (AECL–2705) CALCULATIONS OF THE THERMAL SCATTERING LAW FOR SOLIDS AND LIQUIDS. Paper SM-96/23. Jarvis, R. G. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). June 1967. 11p. (CONF-670707–9). Dep. CFSTI. CAN $0.50.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich.

A method was developed, based on the incoherent approximation, to describe scattering in solids and liquids. It deals with molecules which are made up of one or more types of scatterer, such as UO_2 and D_2O. For each scatterer, there is a scattering law $S(\alpha,\beta) = (1/2\pi)\int_{-\infty}^{\infty} \exp[-\alpha w(t)] \exp(i\beta t)\, dt$ in Egelstaff's notation. The width function w(t) corresponds to a generalized frequency distribution $\rho(\beta)$ which, in its most complicated form, has five components. The first and second describe sharp peaks (such as the two main vibration levels in D_2O), the third and fourth represent broader peaks (such as the combined effects of minor vibration levels and the rotations and translations), the fifth is for diffusion and is omitted for solids. The integral for S is expanded over the vibration terms and then evaluated by a combination of numerical methods and saddle-point integrations. Finally, the S's for the scatterers are combined to give an S for the molecule. (auth) (CANADA)

38147 (AECL–2915) EXPERIMENTAL SCATTERING LAW FOR VARIOUS REACTOR MATERIALS. Paper SM-96/21. Thorson, I. M. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). June 1967. 22p. (CONF-670707–14). Dep. CFSTI. CAN $1.00.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich.

The double differential neutron scattering cross sections for zirconium hydride and uranium dioxide were measured on the Chalk River phased-rotor spectrometer at the NRU reactor. The results are presented in the scattering law, $S(\alpha,\beta)$ form. The UO_2 data were taken for four specimen temperatures; results at 27°C and 500°C cover an energy transfer range 0.005 to 0.09 eV and at 1310°C and 1480°C, a range of 0.01 to 0.18 eV. The ZrH_x data were taken with a specimen temperature of 27°C for x = 0, 0.63, 0.98 and 1.98; in all cases the cross-sections due to acoustical modes are negligible for energy transfers above 0.04 eV and the shape, if any, of the optical peak at 0.14 eV is not resolved because of intensity and resolution limitations. The accuracy with which the absolute normalization and important corrections for background, detector sensitivity and multiple scattering can be made is discussed. Multiple scattering is shown to be a significant effect for the low momentum transfer measurements because it modifies the observed α dependence and the extrapolated S/α value at $\alpha = 0$. (auth)

38148 (BNL–11560) EFFECT OF SCATTERING ANISOTROPY ON THE CALCULATION OF PULSED-NEUTRON DECAY CONSTANTS. Dorning, J. (Brookhaven National Lab., N. Y. Columbia Univ., New York). July 1967. 26p. Dep. CFSTI.

The effect of including various orders of scattering anisotropy in the calculation of pulsed-neutron (die-away) experiment discrete time-decay constants is examined. The fundamental mode thermal neutron decay constants for spherical light water systems are computed using realistic scattering models for the bound hydrogen atoms of the H_2O molecule. Separate calculations were performed using the Nelkin model and the Young and Koppel model. The results of extensive computations of decay constants for small systems using the discrete S_n method are presented. By the use of this method, the introduction of an $e^{\mathbf{B}\cdot\mathbf{r}}$ ansatz and the accompanying vagueness and difficulties in assigning extrapolation distances for small systems is avoided. Comparison with experiment shows that retention of the linearly anisotropic (P–1) term in the scattering kernel is essential and indeed considerably more important than model refinement. The inclusion of higher-order scattering anisotropies (P–2, P–3), however, leads to extremely small changes in the computed decay constants. These results are physically very acceptable since the flux decay in small systems is dominated by leakage. As demonstrated by the calculations, the isotropic scattering approximation underestimates the leakage, whereas the P–1 approximation results in a rather accurate determination of this dominating factor. The use of "transport-corrected" P–0 cross sections results in surprisingly accurate values for the decay constants of systems in the experimental range, and the computations show that this simple efficient method of accounting for scattering anisotropy is adequate for decay-constant calculations in H_2O. Additional information obtained from the calculations include the space-dependent energy spectra. The energy spectrum throughout a typical small system is significantly diffusion cooled, the spectrum at the center being softer than that at the surface. The spectra resulting from P–0 scattering calculations are not cooled quite as much as those obtained by transport-corrected P–0 and higher-order scattering computations which yield almost identical energy distributions for systems in the experimental range. The effects of completely neglecting chemical binding are shown to be significant by comparing decay constants resulting from calculations based on the proton gas model with those obtained for the more realistic anisotropic model. (auth)

38149 (BNL–50061A) SIGMA CENTER, NEUTRON CROSS SECTION COMPILATION CENTER SCISRS NEWSLETTER, PART A, REFERENCE AND BIBLIOGRAPHY. (Brookhaven National Lab., Upton, N. Y.). June 1967. 139p. Dep. CFSTI.

A listing by reference of the literature incorporated into the SCISRS bibliographic system is presented together with a bibliographic index that is listed by accession number (reference abbreviation.) (D.C.W.)

38150 (BNWL–SA–1085) ANALYTICAL EVALUATION OF THE LARGE TIME CONTRIBUTION TO NEUTRON SCATTERING CROSS SECTIONS. Gibbs, A. G.; Lindenmeier, C. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 5, 1967. Contract AT(45-1)-1830. 14p. (CONF-670707–4). Dep. CFSTI.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich.

The Legendre moments of the neutron scattering cross section are computed by integrating the integral representation of the scattering law, $S(\alpha,\beta)$, over angles, thus providing a representation of the moments of the cross section as cosine transforms. The method is particularly advantageous if the moments are required at only a few energy points, since the necessity of evaluating $S(\alpha,\beta)$ at a much greater number of points is eliminated. The method presented differs from past treatments both in the method of evaluating the cosine transform, and in the addition of a special treatment of the large time contribution. (S.F.L.)

38151 (EUR–3210.f(Vol.2)) CONDITIONS OPTIMALES DE FONCTIONNEMENT DU GENERATEUR DE NEUTRONS. Rapport Annuel Avril 1965–Avril 1966. (Optimum Operating Conditions for the Neutron Generator. Annual Report, April 1965–April 1966). Vernin, E.; Perdijon, J. (Societe Anonyme de Machines Electrostatiques, Grenoble (France)). June 1967. 88p. (In French). Dep.

In order to permit the use of the facility for neutron activation analysis, a statistical study was made of the performance of 22 tritium targets, and a catalog of γ spectra obtained by fast and thermal neutron activation of various elements under defined counting and irradiation conditions was developed. A table of sensitivities was calculated for 47 frequently encountered elements. The installation was then used to analyze samples sent in by industrial concerns and laboratories; the results show that certain analytical problems can easily be solved by activation analysis using an accelerator. (D.C.W.)

38152 (EUR–3210.f(Vol.3)) CONDITIONS OPTIMALES DE FONCTIONNEMENT DU GENERATEUR DE NEUTRONS. Rapport Final. (Optimum Operating Conditions for the Neutron Generator. Final Report). Vernin, E.; Perdijon, J. (Societe Anonyme de Machines Electrostatiques, Grenoble (France)). June 1967. 34p. (In French). Dep.

A range of investigations carried out with the generator is described, together with the results of a study program made with a view to define experimental conditions for activation analysis using a 14 MeV neutron generator. The optimization of the various elements making up an activation analysis assembly was examined. These elements are: the neutron generator (a SAMES "J" type 150 kV 1 mA accelerator) fitted with tritium targets, the neutron flux monitor (recoil proton scintillator), pneumatic transfer system, gamma spectrometer (NaI scintillator coupled to a 400-channel pulse height analyzer), neutron thermalization, shielding devices and the sample-holders. A catalog of spectra was made up to determine the analytical possibilities of this installation. The installation was employed for carrying out a certain number of typical analyses chosen from widely varying types of activity. Finally, a comparative study of the tritium targets employed is carried out. (auth)

38153 (GA-7092) STATUS OF THERMAL NEUTRON SPECTRA. Beyster, J. R.; Neill, J. M. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). June 9, 1967. Contract AT(04-3)-167. 44p. (CONF-670707-7). Dep. CFSTI.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich.

Some improvements in methods of calculating and measuring thermal neutron spectra are reviewed together with the status of spectral measurements. (D.C.W.)

38154 (GA-8030) ANGULAR SCATTERING BY CH_2, $ZrH_{1.85}$ AND C_6H_6. Beyster, J. R.; Borgonovi, G. M.; Carriveau, G. W. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). June 12, 1967. Contract AT(04-3)-167. 20p. (CONF-670707-8). Dep. CFSTI.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich.

The single differential angular cross sections for scattering of neutrons by CH_2, $ZrH_{1.85}$, and C_6H_6 were measured using a time-of-flight technique. The measurements in CH_2 and C_6H_6 were made at room temperature, while the measurements in $ZrH_{1.85}$ were made at room temperature and at 700°K. The experimental results were compared with theoretical predictions. (D.C.W.)

38155 (GA-8031) NEUTRON SCATTERING IN BERYLLIUM. Koppel, Juan U.; Young, James A. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). June 12, 1967. Contract AT(04-3)-167. 13p. (CONF-670707-11). Dep. CFSTI.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich.

The phonon dispersion curves and frequency spectrum for beryllium are calculated using the adiabatic approximation. (D.C.W.)

38156 (GA-8050) NEUTRON THERMALIZATION IN DIPHENYL. Neill, J. M.; Antunez, H.; Sprevak, D. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). June 14, 1967. Contract AT(04-3)-167. 15p. (CONF-670707-5). Dep. CFSTI.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich.

The comparisons of Sprevak's scattering theory for benzene to measurements that have been made of the total cross section of benzene, of the quasi-infinite medium spectrum in benzene and in diphenyl as a function of poison, and of the position dependent thermal neutron spectra at a D_2O-diphenyl interface are described. The results show that the Sprevak model for hydrogen in benzene predicts the cross section and thermal neutron spectra in that moderator reasonably well. However, the Sprevak model for hydrogen in benzene predicts a thermal neutron spectrum in molten diphenyl that is too hard. (D.C.C.)

38157 (GA-8052) MULTIPLE SCATTERING IN NEUTRON DOUBLE DIFFERENTIAL CROSS SECTION MEASUREMENTS. Slaggie, E. L. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). June 13, 1967. Contract AT(04-3)-167. 18p. (CONF-670707-6). Dep. CFSTI.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich.

Some methods of correcting double differential data for multiple scattering are reviewed, and the double differential scattering of 0.039-eV neutrons by a slab of water at room temperature is treated as a numerical example. The effects of varying the thickness of the sample are studied. The corrections for double differential scattering by zirconium hydride are also treated as an example. (D.C.W.)

38158 (IN-1094) SEARCH FOR THE KOHN EFFECT IN LIQUID LEAD. Randolph, P. D. (Idaho Nuclear Corp., Idaho Falls). June 1967. Contract AT(10-1)-1230. 19p. Dep. CFSTI.

Recent theoretical calculations have shown that the so-called Kohn anomaly may be observable by neutron scattering in liquid metals, thus furnishing a new way of measuring the Fermi Surface in these materials. The effect is expected to appear as a discontinuity in a curve of quasi-elastic widths as a function of neutron momentum transfer. The MTR phased-chopper velocity selector was used for slow neutron scattering measurements of the quasi-elastic widths in liquid lead at 350°C. These measurements were made at six incident energies in the range $0.015 \leq E_0 \leq 0.025$ eV and span momentum changes $\hbar\kappa$ in the range $1.8 \leq \kappa \leq 4.5$ Å^{-1}. No Kohn anomaly was observed within the accuracy of the experiment. The variation of the widths agrees with the calculations of DeGennes at the first diffraction maximum and minimum, but not at large κ. (auth)

38159 (LA-DC-8858) SOURCES OF POLARIZED NEUTRONS. Seagrave, John D. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 18p. (CONF-670629-4). Dep. CFSTI.

From Symposium on Light Nuclei, Few Body Problems, and Nuclear Forces, Brela, Yugoslavia.

The three most extensively studied natural sources of polarized fast neutrons, $T(p,n)^3He$, $D(d,n)^3He$, and $T(d,n)^4He$, are examined together with the charge-conjugate reactions $D(d,p)T$ and $^3He(d,p)^4He$, not primarily to detail the regions of polarizations of magnitudes useful as sources for other experiments, as these are reasonably well known and recently reviewed elsewhere, but to obtain a comprehensive view of the extent of information presently available for the complete description of the reactions involved. To afford this perspective, available data are represented in families of polarizations plotted as a function of the cosine of the cms neutron (or proton) angles, and displaced along an oblique energy axis. The $T(p,n)^3He$ reaction, for which the cross sections are the most completely known, is however the least completely studied in terms of polarization. The LASL Polarized Ion Source is briefly described. (auth)

38160 (ORNL-P-3206) (p,n) AND (d,n) TIME-OF-FLIGHT EXPERIMENTS. Stelson, P. H. (Oak Ridge National Lab., Tenn.). [1967]. Contract W-7405-eng-26. 31p. (CONF-670615-3). Dep. CFSTI.

From Symposium on Nuclear Physics Research with Low-Energy Accelerators, College Park, Md.

The resolution of neutron groups in time-of-flight experiments is discussed with emphasis on (d,n) and (p,n) reactions. Some (d,n) and (p,n) experiments are summarized. (D.C.W.)

38161 (PRNC-78) FORTRAN PROGRAM FOR CALCULATION OF NEUTRON DIFFRACTION MAGNETIC INTENSITIES. Kay, M. I.; Cromer, Don T. (Puerto Rico Nuclear Center, Mayaguez). [nd]. Contract AT(40-1)-1833. 14p. Dep. CFSTI.

A computer program for calculating the intensities of neutron-diffraction magnetic reflections is described. The computer program is written in FORTRAN for the IBM 1620. (D.C.W.)

38162 (UJV-1600) INTEGROVANI TOKU RYCHLYCH I POMALYCH NEUTRONU Ni FOLIEMI PRI PROMENNEM REZIMU OZAROVANI. (Integration of Fluxes of Fast and Slow Neutrons With Ni Foils Using Varied Conditions of Irradiation). Kadlec, V. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Nov. 1966. 20p. (In Czech). Dep.

Several methods are given for applying ^{58}Ni as an activation integrator for neutron flux determinations. These use different regimes for irradiation and different levels of power and thermal flux. In general a method using two foils is employed, but when the thermal flux is greater than $10^{13}n/cm^2sec$, it is possible to determine both fast and slow neutrons simultaneously from a single foil. Graphs which expedite the evaluation of irradiated Ni foils are also given. (TTT)

38163 INELASTIC-SCATTERING CROSS SECTION OF NEUTRONS BY CRYSTAL VIBRATIONS OF POLYETHYLENE. Kitagawa, Teizo; Miyazawa, Tatsuo (Osaka Univ.). J. Chem. Phys., 47: 337-8(July 1, 1967).

A theoretical study of the effects of crystal vibrations on neutron inelastic scattering by polyethylene is summarized. (D.C.W.)

38164 MEASUREMENT OF THE DT-NEUTRON YIELD BY MEANS OF AN AUXILIARY ANNIHILATION RADIATION SOURCE. Bukarev, V. A.; Komissarov, V. A.; Shtan, A. S. At. Energ. (USSR), 22: 409(May 1967). (In Russian).

The absolute yield of DT-neutron generators in sealed tubes is usually measured by activation, taking advantage of the (n,2n) reaction which results in the formation of positron-active nuclei. When large specimens are used, it is difficult to determine the recording efficiency; this is due especially to the annihilation quanta coincidences. The required angular correction was found to be obtainable by two supplementary measurements: coincidence and single-crystal spectrometer measurements. An auxiliary positron radiation source, such as ^{22}Na, possessing the same dimensions as the activated specimen is required. The precision of the absolute yield determination by this method amounts to about 20%. (TTT)

38165 ANALYTICAL METHOD FOR SOLVING CRITICAL PROBLEMS. Shikhov, S. B.; Davydov, V. I.; Shishkov, L. K. At. Energ. (USSR), 22: 410-11(May 1967). (In Russian).

The equation of a plane-parallel multiregion reactor in the P_{2n+1}-m group approximation may be presented in the compact vector-matrix form, assuming that the fission-neutron distribution is uniform. The solution is based on the correlation between the neutron distribution and the flux and current at the boundary; it may be extended beyond the last boundary. It is shown that the boundary problem of an N-region reactor may be used for solving the $m(n + 1)$ system, whereby m is the number of neutron groups of homogeneous linear equations with respect to the vector component. The critical condition is the fact that the determinant of the equation system is equal to zero, making it possible to find the

k_{eff} of the reactor or the critical dimension of the region containing the fissioning isotope. Under critical conditions, these equations possess a nontrivial solution. The algorithm developed was programmed for the multigroup P_1 approximation in plane and cylindrical geometries. The multiregion boundary problem with an arbitrary distribution of the functions may also be solved analytically. (TTT)

38166 SPIN-ORBIT INTERACTION AND POLARIZATION OF SLOW NEUTRONS. Obermair, G. (Technische Hochschule, Munich). Z. Phys., 204: 215-22(1967).

It is shown that the spin-orbit (LS) interaction of an anomalous magnetic moment is twice that of a Dirac moment. In neutron scattering, this interaction leads to an imaginary spin-dependent scattering amplitude. Possible experiments are discussed, where interference of LS scattering and nuclear scattering in crystals without inversion symmetry leads to detectable neutron polarization. (auth)

38167 NEUTRON–MAGNON INTERACTION INVOLVING ORBITAL TRANSITIONS. Joshi, A. W.; Sinha, K. P. (National Chemical Lab., Poona). Proc. Phys. Soc. (London), 91: 97-104(May 1967).

The two-magnon interaction of neutrons in magnetically coupled systems, namely ferromagnetic and ferrimagnetic crystals, is considered. The interaction mechanism is relevant to magnetic systems having magnetic atoms the states of which allow orbital transitions due to interaction with neutrons. The formulation of the Heisenberg-type exchange interaction in terms of atomic states, which are perturbed owing to the scattering with neutrons, gives rise to the interaction terms. In effect they represent two-magnon Raman processes along with the scattering of neutrons. The calculations are carried out for ferromagnetic and ferrimagnetic systems. The scattering cross sections are evaluated in terms of the matrix elements of the neutron–magnon interaction between the combined neutron–magnon states. The final expressions for the scattering cross sections, evaluated in the long magnon wavelength and low-temperature approximation, contain temperature T in different powers. (auth) (UK)

38168 NEUTRON TRANSPORT FROM A POINT SOURCE IN TWO ADJACENT, DISSIMILAR, SEMI-INFINITE MEDIA. Erdmann, R. C. (Univ. of California, Los Angeles). J. Math. Phys., 8: 1040-4(May 1967).

A solution to the steady-state, two-dimensional Boltzmann equation is obtained for the flux due to a point source of neutrons located in a system of two adjacent half-spaces having the same mean-free path. Isotropic scattering and monoenergetic neutrons are assumed. The solution for an arbitrary source location is related to that for an interface source which is obtained by the Wiener–Hopf technique. Asymptotic expansions for the flux far from the source, both along and away from the interface, are derived and compared with approximate theory. (auth)

38169 TRANSACTIONS OF THE AMERICAN NUCLEAR SOCIETY 1967 ANNUAL MEETING, SAN DIEGO, CALIFORNIA, JUNE 11–15, 1967. Trans. Amer. Nucl. Soc., 10: 1-411(June 1967). (CONF-670602).

The Transaction includes summaries of 467 papers. Each paper is title listed in NSA. (C.E.S.)

For titles of individual papers see: 35855–35859, 35861–35885, 35931, 35996–36003, 36061, 36062, 36089–36092, 36107–36112, 36151, 36152, 36176, 36190, 36209–36215, 36238–36244, 36266–36275, 36303–36306, 36315–36321, 36327, 36358, 36361–36368, 36407–36412, 36417, 36430–36439, 36477, 36483, 36484, 36584–36588, 36629, 36763, 36791–36794, 36808, 36809, 36837–36840, 36883–36894, 36907–36909, 36916, 36945–36948, 36954–36956, 37285, 37512–37542, 37969–37971, 38170–38211, 38237, 38238, 38264–38268, 38305–38320, 38385, 38386, 38476–38584, 38631–38646, 38678–38734, 38737, 38738, and 38746–38766.

38170 INTERPRETATION OF NEUTRON-WAVE EXPERIMENTS. Akcasu, A. Ziya (Univ. of Michigan, Ann Arbor). Trans. Amer. Nucl. Soc., 10: 203(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38171 A GENERALIZED SPACE-POINT ESTIMATOR FOR MONTE CARLO CALCULATIONS. Layno, Salvador B. (The Boeing Co., Seattle); Babb, Albert L. Trans. Amer. Nucl. Soc., 10: 237-8(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38172 BIORTHOGONAL ANGULAR POLYNOMIAL EXPANSIONS OF THE TWO-DIMENSIONAL TRANSPORT EQUATION. Lathrop, K. D. (Los Alamos Scientific Lab., N. Mex.); DeMuth, N. S. Trans. Amer. Nucl. Soc., 10: 206-7(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38173 MILNE PROBLEM WITH ABSORPTION AND THE ALBEDO OF A SEMI-INFINITE MEDIUM. Mockel, Andre J. (Univ. of Florida, Gainesville). Trans. Amer. Nucl. Soc., 10: 207-8(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38174 ENERGY-DEPENDENT NEUTRON TRANSPORT THEORY NEAR A TEMPERATURE DISCONTINUITY. Gritton, Eugene C. (The Rand Corp., Santa Monica, Calif.); Leonard, Anthony; Barrett, Paul R. Trans. Amer. Nucl. Soc., 10: 208-9(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38175 FOURIER SERIES SOLUTION TO INFINITE CYLINDER PROBLEMS. Hendry, W. L. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 10: 209-10(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38176 FOURIER TRANSPORT APPROACH. Papmehl, N. (Euratom Joint Research Center, Ispra, Italy). Trans. Amer. Nucl. Soc., 10: 210(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38177 NEUTRON TRANSPORT IN FINITE SPHERES. Erdmann, R. C. (Univ. of California, Los Angeles). Trans. Amer. Nucl. Soc., 10: 211-12(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38178 PERIODIC SOLUTIONS OF THE MONOENERGETIC BOLTZMANN EQUATION. Aviram, I. (Atomic Energy Commission of Israel, Beer-Sheba); Yeivin, Y. Trans. Amer. Nucl. Soc., 10: 212-13(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38179 METHOD FOR SOLVING TIME-DEPENDENT TRANSPORT PROBLEMS. Tavel, M.; Zucker, M. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 10: 213(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38180 ANGULAR SYNTHESIS APPROXIMATION APPLIED TO THIN CRITICAL SLABS. Zwibel, H. S. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 213-14(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38181 NEUTRON ABSORPTION RATE PREDICTIONS FOR MATERIALS WITH ANISOTROPIC EFFECTIVE MACROSCOPIC CROSS SECTIONS. Kurey, T. J.; Kopp, H. J. (Knolls Atomic Power Lab., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 10: 214-15(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38182 SIMPLE MODEL OF NEUTRON-WAVE PROPAGATION. Duderstadt, J. J. (California Inst. of Tech., Pasadena). Trans. Amer. Nucl. Soc., 10: 277(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38183 NEUTRON-WAVE ANALYSIS USING FOURIER TRANSFORM METHODS. Warner, J.; Erdmann, R. C. (Univ. of California, Los Angeles). Trans. Amer. Nucl. Soc., 10: 278-9(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38184 REMARKS ON NEUTRON-WAVE ANALYSIS. Nishina, Kojiro; Akcasu, A. Ziya (Univ. of Michigan, Ann Arbor). Trans. Amer. Nucl. Soc., 10: 279(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38185 THERMAL-NEUTRON-WAVE PROPAGATION IN A REFLECTED ASSEMBLY. Ohanian, M. J.; DuBois, Quentin B.; Kang, Changmu; Perez, R. B. (Univ. of Florida, Gainesville). Trans. Amer. Nucl. Soc., 10: 279-80(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38186 EXPERIMENTAL KINETIC STUDIES ON DEPLETED-URANIUM SPHERE. Gozani, T. (General Atomic Div., General Dynamics Corp., San Diego, Calif.); Moore, R. A.; Neill, J. M.; Main, G. Trans. Amer. Nucl. Soc., 10: 280-1 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38187 AN EXPERIMENTAL STUDY OF THE EFFECT OF EMPTY CHANNELS ON THE NEUTRON-DIFFUSION COEFFICIENT IN GRAPHITE. Bennett, Leonard L. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 281-2 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38188 PROMPT-NEUTRON DECAY CONSTANTS CALCULATED IN HIGHLY ENRICHED URANIUM METAL ASSEMBLIES. Morrison, G. W. (Union Carbide Corp., Oak Ridge, Tenn.); Knight, J. R.; Irving, D. C. Trans. Amer. Nucl. Soc., 10: 223-4 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38189 REACTIVITY EFFECTS OF LOW NEUTRON ABSORBER SAMPLES IN THE ARMF REACTORS. Wilson, A. E.; Fast, E.; Rogers, J. W.; Millsap, D. A. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc., 10: 224-5 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38190 EXISTENCE OF THE FUNDAMENTAL MODE FOR AN INFINITE SLAB. Bednarz, R. J. (Univ. of Arizona, Tucson). Trans. Amer. Nucl. Soc., 10: 291 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38191 NEUTRON-POSITION-DEPENDENT SPECTRUM IN A MULTIPLYING ASSEMBLY. Cerbone, R. J.; Slovacek, R. E.; Gaerttner, E. R. (Rensselaer Polytechnic Inst., Troy, N. Y.). Trans. Amer. Nucl. Soc., 10: 291-2 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38192 AN EXPERIMENTAL DETERMINATION OF THE LAGUERRE COEFFICIENTS FOR SPECTRAL EXPANSIONS. Jedruch, Jacek (Westinghouse Electric Corp., Cheswick, Pa.). Trans. Amer. Nucl. Soc., 10: 292-3 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38193 INELASTIC SCATTERING OF THERMAL NEUTRONS BY REACTOR-GRADE GRAPHITE. Hom, A. K.; Whittemore, W. L. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 293-4 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38194 INELASTIC THERMAL-NEUTRON SCATTERING BY LIQUID D_2O. Whittemore, W. L.; Hom, A. K. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 294-5 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38195 PULSED-NEUTRON EXPERIMENTS IN LIGHT WATER. Dorning, J. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 10: 295-6 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38196 NEUTRON THERMALIZATION TIME CONSTANT MEASUREMENTS IN WATER. Adamantiades, A. G. (Iowa State Univ., Ames); Clikeman, F. M.; Rasmussen, N. C. Trans. Amer. Nucl. Soc., 10: 296-7 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38197 NEUTRON SPECTRA IN COLD BERYLLIUM. Neill, J. M. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 297 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38198 ANGULAR SCATTERING BY ZIRCONIUM HYDRIDE AT ELEVATED TEMPERATURES. Carriveau, G. W.; Borgonovi, G.; Beyster, J. R. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 297-8 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38199 FREQUENCY DISTRIBUTION OF MOLECULAR SOLIDS FROM THERMAL-NEUTRON SCATTERING. Prask, Henry (Picatinny Arsenal, Dover, N. J.); Boutin, Henri; Yip, Sidney. Trans. Amer. Nucl. Soc., 10: 298-9 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38200 ANALYSIS OF FAST-NEUTRON SPECTRUM MEASUREMENTS IN PARAFFIN. Profio, A. E.; Naliboff, Y. D.; Huffman, D. L. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 392 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38201 SENSITIVITY OF CALCULATIONS OF NEUTRON TRANSPORT IN OXYGEN TO VARIOUS CROSS-SECTION SETS. Straker, E. A.; Emmett, M. B. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 392-3 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38202 ERROR ESTIMATES FOR APPROXIMATE EIGENVALUES TO THE INTEGRAL TRANSPORT EQUATION. Sargis, David A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 170 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38203 STRATEGY FOR THE APPLICATION OF SPACE-ANGLE SYNTHESIS. Natelson, M. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 10: 171-2 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38204 MULTIGROUP TWO-DIMENSIONAL NEUTRON TRANSPORT. Crawford, Bruce W.; Friedman, Jack P. (Knolls Atomic Power Lab., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 10: 172 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38205 INITIAL STUDIES OF COLLAPSED GROUP-SPACE SYNTHESIS: ANOMALIES ARISING FROM THE USE OF ADJOINT WEIGHTING. Yasinsky, J. B.; Kaplan, S.; Jason, R. H. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 10: 172-3 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38206 BLOCK INVERSION METHOD: A NEW APPROACH TO MULTIDIMENSIONAL REACTOR CALCULATIONS. Kraetsch, H.; Wagner, M. (General Dynamics, Zurich). Trans. Amer. Nucl. Soc., 10: 173-4 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38207 NUMERICAL METHOD FOR THE THREE-DIMENSIONAL MULTIGROUP EQUATIONS. Hansen, K. F. (General Atomic Div., General Dynamics Corp., San Diego, Calif.); Johnson, Stephen R.; Storat, Richard E. Trans. Amer. Nucl. Soc., 10: 174-5 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38208 CANONICAL AND INVOLUTORY TRANSFORMATIONS OF VARIATIONAL PROBLEMS INVOLVING HIGHER DERIVATIVES. Kaplan, S. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 10: 175-6 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38209 VARIATIONAL PRINCIPLE FOR THE DETERMINATION OF PSEUDOFUNDAMENTAL DECAY EIGENVALUES. Jenkins, J. D.; Daitch, P. B. (Rensselaer Polytechnic Inst., Troy, N. Y.). Trans. Amer. Nucl. Soc., 10: 177 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38210 PERTURBATION METHOD THAT UTILIZES THE VARIATIONAL PRINCIPLES ASSOCIATED WITH THE NEUTRON-DIFFUSION EQUATION. Turley, Richard E. (Iowa State Univ., Ames). Trans. Amer. Nucl. Soc., 10: 177-8 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38211 FAST-NEUTRON SPECTRA IN A DEPLETED-URANIUM SPHERE. Moore, R. A.; Neill, J. M.; Gozani, T.; Russell, J. L. Jr. (General Atomic Div., General Dynamics

Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 267 (June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

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Refer also to abstracts 37837, 38159, 38241, 38264, 38381, and 38401.

38212 (AD-654739) RADIATIVE CAPTURE OF ^{3}He BY ^{3}He. Harrison, W. D.; Stephens, W. E.; Tombrello, T. A.; Winkler, H. (California Inst. of Tech., Pasadena). June 1967. 18p. CFSTI.

The reaction $^3He + ^3He \rightarrow ^6Be^* + \gamma$ was observed at 90° for bombarding energies between 0.86 and 11.8 MeV. The total cross section for transitions to the first excited state of ^{6}Be varies smoothly from 0.4 to 9.3 microbarns (assuming isotropy). No gamma-ray transitions to the ground state of ^{6}Be were observed with an upper limit of approximately 10^{-2} microbarns at 1.4 MeV. Because of these low cross sections, this reaction is of negligible astrophysical importance compared to the ^{3}He(^{3}He,2p)^{4}He reaction. (auth)

38213 (AD-656034) THE SCATTERING OF ^{3}He BY ^{4}He AND OF ^{4}He BY TRITIUM. Spiger, R. J.; Tombrello, T. A. (California Inst. of Tech., Pasadena). May 1967. 65p. CFSTI.

The differential elastic scattering cross section was measured for the scattering of ^{3}He from ^{4}He and the scattering of ^{4}He from tritium for bombarding energies of 5 to 18 MeV and 4 to 18 MeV, respectively. Data were also obtained for the reactions ^{4}He(^{3}He,p)^{6}Li, ^{4}He(^{3}He,p')^6*Li, ^{3}H(α,n)^{6}Li, and ^{3}H(α,n')^6*Li. Levels are seen at 4.65, 6.64, 7.47, and 9.7 MeV in ^{7}Li and at 4.57, 6.73, 7.21, and 9.3 MeV in ^{7}Be. A phase-shift analysis suggests assignments of $\frac{7}{2}^-$ and $\frac{5}{2}^-$ for the two lower levels in ^{7}Li, confirms the $\frac{5}{2}^-$ assignment of the 7.47 level, and suggests a $\frac{7}{2}^-$ assignment for the new level at 9.7 MeV. Similarly in ^{7}Be, the assignments of $\frac{7}{2}^-$ and $\frac{5}{2}^-$ for the lower two levels are confirmed, and an assignment of $\frac{7}{2}^-$ is suggested for the new level at 9.3 MeV. The reduced widths for α and nucleon emission were determined by fitting the phase shifts near each level with a single and/or double level formula from the R-matrix formalism of Lane and Thomas. The results of the analysis are discussed and are compared with predictions of recent nuclear model calculations. (auth)

38214 (JINR-P4-3384) O SKOROSTI REAKTSII SINTEZA V MEZOMOLEKULE ddμ S MOMENTOM 1. (On the Rate of the Synthesis Reaction in a Mesomolecule ddμ With the Momentum I). Vesman, E. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 12p. (In Russian). Dep.

The rate of a nuclear reaction in a mesomolecule $(dd\mu)^+$, which was formed in a state with momentum K = 1, is estimated. It is found that the rate of the synthesis reaction from the p-state is of the same order as from the s-state, and its value is of the order 10^{10} to 10^{11} sec^{-1}. (auth)

38215 (LA-DC-8857) NEUTRON-DEUTERON SCATTERING LENGTHS AND THE S-WAVE PHASE SHIFTS. Seagrave, John D. (Los Alamos Scientific Lab., N. Mex.); van Oers, W. T. H. (California Univ., Los Angeles). [1967]. Contract W-7405-eng-36. 18p. (CONF-670629-3). Dep. CFSTI.

From Symposium on Light Nuclei, Few Body Problems, and Nuclear Forces, Brela, Yugoslavia.

New data on coherent and incoherent neutron-deuteron scattering permit re-evaluation of the doublet and quartet scattering lengths, with the results $^4a = 6.14 \pm 0.06$ fm, and $^2a = 0.11 \pm 0.07$ fm. These values imply $\sigma_{free} = 3.14 \pm 0.06$ barns. A comparison is made with the values obtained from extrapolations of the ^{4}S and ^{2}S phase shifts for n–D and p–D elastic scattering. For the n–D ^{2}S phase shift $^2\delta_0$, the effective-range representation of k cot($^2\delta_0$) exhibits a term with a "pole" at a negative energy corresponding to $E_{lab} \approx -0.1$ MeV. (auth)

38216 POLARIZATION OF NEUTRONS FROM THE REACTION ^{3}H(d,n)^{4}He. Busse, W.; Christiansen, J.; Hilscher, D.; Morfeld, U.; Scheer, J. A.; Schroeder, W. U. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Phys., A100: 490–6 (1967).

The angular dependence of the polarization of neutrons from the reaction ^{3}H(d,n)^{4}He was measured at deuteron energies of 3.35, 4.35 and 5.35 MeV for reaction angles up to 165° lab. Polarization values were derived from the left-right asymmetry in n-α scattering. (auth)

38217 K-MESONIC X RAYS AND K$^-$ ABSORPTION IN LIQUID HELIUM. Michael, Daniel N. (Argonne National Lab., Ill. Univ. of Chicago). Phys. Rev., 158: 1343–59(June 25, 1967).

An experiment is described in which K-mesonic x rays were observed in ^{4}He. The experiment was performed in an unseparated beam by selecting K$^-$ stopping in a liquid-helium target with a system of fast counters, and observing the x rays in a gas proportional counter gated by the stopping signal. An x-ray line was observed at 6.5 ± 0.4 keV and was identified to be the L_α transition of kaonic helium. There was also some evidence for a second line in the spectrum at 35.4 ± 0.9 keV, assumed to be the K_α, with an intensity of (49 ± 22)% relative to the L_α. The absolute yield of the L_α transition was determined to be (85 ± 25)%. This directly establishes that most K$^-$ are absorbed from low-lying states in helium. A simple model was constructed for the de-excitation of kaonic helium and was used to calculate the atomic cascade. With reasonable assumptions about the initial population of states, this calculation gave values for both the L_α yield and the cascade time consistent with the experimental values, and was used to predict a nuclear-capture schedule for K$^-$ in helium. From the line assumed to be the K_α, it was possible to deduce an upper limit for the complex-energy shift to the 1S level from the K-α interaction, and a value for the absorption rate from the 2P level. (auth)

38218 BOUND-STATE EIGENVALUE CALCULATION. Ali, Shamsher; Islam, Mozaharul (Atomic Energy Centre, Dacca, Pakistan). J. Natur. Sci. Math., 6: 177–81(Oct. 1966).

A method was sought for solution of the radial Schroedinger equation for a bound system of 2 particles for real and central potentials. Using this method, the binding energies of a number of two-body systems were calculated with fairly realistic potentials and were found to agree very well with the experimental values. The rapidity of the calculations depends on a good guess of the binding energy. (auth)

38219 A SEARCH FOR EXCITED STATES OF ^{3}He. Slobodrian, R. J.; McKee, J. S. C.; Clark, D. J.; Tivol, W. F.; Tombrello, T. A. (Univ. of California, Berkeley). Nucl. Phys., A101: 109–12(1967). (UCRL-17422).

The ^{3}He + ^{3}He interaction does not excite sharp states of ^{3}He with a cross section larger than 120 μb/sr below 30-MeV excitation. (auth)

38220 63-MeV DEUTERON SCATTERING ON C, Al, AND H. Auld, E. G. (Univ. of Southampton, Eng.); Crabb, D. G.; McEwen, J. G.; Bird, L.; Whitehead, C.; Wood, E. Nucl. Phys., A101: 65–80(1967).

The angular distribution of elastically scattered 63-MeV deuterons was measured for carbon, aluminium, and hydrogen, using sonic spark chambers. Optical-model fits were made to the results for carbon and aluminium. The cross section for deuteron stripping on carbon was measured to be 65 ± 5 mb. (auth)

38221 POLARIZATION PHENOMENA IN THE DIRECT AND INVERSE PHOTONUCLEAR REACTIONS WITH TRITIUM AND ^{3}He. Fetisov, V. N. (Lebedev Inst. of Physics, Moscow). Phys. Lett., 25B: 94–8(Aug. 7, 1967).

The polarization phenomena in the reactions $\gamma + {}^3H({}^3He) \rightleftharpoons n(p) + d$ with polarized beams of γ rays and nucleons are discussed. (auth)

38222 ON THE COHERENT PHOTOPRODUCTION ON ^{4}He. Bosco, B. (Univ., Cagliari, Italy); Ciocchetti, G. Phys. Lett., 25B: 102–3(Aug. 7, 1967).

A model-independent analysis of the reaction $\gamma + {}^4He \rightarrow {}^4He + \pi^0$ is done, and the possibility of utilizing it as a direct source of information on the Brueckner effect in nuclei is emphasized. Some experiments are discussed. (auth)

38223 UNBOUND ENERGY LEVELS IN ^{4}H. Measday, D. F. (Harvard Univ., Cambridge, Mass.); Palmieri, J. N. Phys. Lett., 25B: 106–8(Aug. 7, 1967).

The reaction ^{4}He(n,p)^{4}H was studied with 152-MeV monokinetic neutrons. Structure in the proton spectra is interpreted as excitation of 1$^-$ unbound levels in ^{4}H. No bound levels of ^{4}H are observed. (auth)

38224 STUDIES OF THE PROTON–PROTON BREMSSTRAHLUNG PROCESS AT THE UNIVERSITY OF MANITOBA. Thompson, J. C. (Univ. of Manitoba, Can.). Phys. Can., 23: No. 3, 6–12(Summer 1967).

A new experimental technique is described for studying low-energy (~50 MeV) proton–proton bremsstrahlung processes. The technique uses wire spark chambers and a small on-line computer for data handling. Some advantages of the system include increase in counting rate while maintaining good geometry, complete removal of slit scattered protons since each detected proton is traced back to its origin, and possibility of investigating events where the outgoing protons are not coplanar with the incident beam direction. (S.F.L.)

38225 MEASUREMENTS OF THE REACTIONS (x,n) AT LOW ENERGIES. Bodart, F.; Deconninck, G. (Louvain Univ.,

Belg.). Ann. Soc. Sci. Brux. Ser. 1, 81: 137-47(1967). (In French).

A method for production of a short neutron burst is presented, and the spectra of neutrons from the T(p,n), ^{9}Be(p,n), T(d,n), and ^{9}Be(^{3}He,n) reactions are given. A method of absolute calibration and of analysis of time-of-flight spectra is described as well as the determination of energy groups from a direct spectrum of neutrons in stilbene. (auth)

38226 STUDY OF NEUTRON-INDUCED REACTIONS ON ^{3}He AT E_n = 14.4 MeV. Antolkovic, B.; Paic, G.; Tomas, P.; Rendic, D. (Inst. Ruder Boskovic, Zagreb). Phys. Rev., 159: 777-81 (July 20, 1967).

Angular distributions of the ^{3}He(n,d)D and ^{3}He(n,p)T processes with 14.4-MeV neutrons were measured using a gas ^{3}He target and a counter-telescope system. The differential cross sections for elastic scattering, ^{3}He(n,n)^{3}He, were obtained by the same technique, detecting recoil ^{3}He particles in the range from 0 to 40° (lab). The theoretical analysis of the data was made within the framework of existing theories. The Legendre-polynomial-expansion curves fitted to the data are also presented. (auth)

38227 RESONATING-GROUP CALCULATION OF ^{3}He–^{3}He SCATTERING. Thompson, D. R.; Tang, Y. C. (Univ. of Minnesota, Minneapolis). Phys. Rev., 159: 806-15(July 20, 1967).

The ^{3}He–^{3}He elastic scattering is considered in the cms energy range of 0 to 20 MeV using the resonating-group method in the one-channel approximation. A two-body central potential of Gaussian form which fits the low-energy nucleon-nucleon scattering data as well as possible is used. The saturation character which is not contained in this potential is approximately taken into account by fixing the radii of the clusters according to experimental data. Phase shifts up to l = 6 are calculated, and a rather broad l = 3 resonant level in ^{6}Be with an excitation energy of about 25 MeV is predicted. Angular distributions are calculated at ten energies. The agreement with experimental data in the range 1.5 to 6.0 MeV is excellent, while that with the data from 6.0 to 12.0 MeV is somewhat worse, but still satisfactory. An optical-model analysis is also performed at an energy of 12 MeV, and a reaction cross section of about 450 mb is predicted. This indicates that, at higher energies, channels other than the ^{3}He–^{3}He channel should be included in the resonating-group calculation to achieve a better agreement with experiment. (auth)

38228 THE 2p FINAL-STATE INTERACTION IN THE ^{3}He(^{3}He,α)2p REACTION. Slobodrian, R. J.; McKee, J. S. C.; Tivol, W. F.; Clark, D. J.; Tombrello, T. A. (Univ. of California, Berkeley). Phys. Lett., 25B: 19-22(July 24, 1967).

The angular variation of the α-particle spectra from the reaction ^{3}He(^{3}He,α)2p was measured at 43.7 MeV and 53.0 MeV laboratory energy. The energy spectra show a prominent peak at the high-energy end and its angular distributions exhibit a pronounced diffraction pattern. Good fits to the spectra are obtained with the Watson–Migdal final-state formalism using the known p-p scattering parameters. (auth)

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Refer also to abstracts 37697, 37838, 38212, 38220, 38301, 38371, 38377, 38392, 38404, and 38423.

38229 (CALT-68-113) PROTON POLARIZATION IN THE SCATTERING OF 90 TO 300 MeV PROTONS FROM ^{12}C. Internal Report No. 30. McNeely, W. A. Jr. (California Inst. of Tech., Pasadena. Synchrotron Lab.). Feb. 2, 1967. Revised Aug. 2, 1967. Contract AT(11-1)-68. 25p. Dep. CFSTI.

The analyzing power for elastic and inelastic scattering of protons by ^{12}C was calculated as a function of proton energy, scattering angle, and the inelasticity of the scatterer. An analyzing power was associated with each discrete state of ^{12}C. (D.C.W.)

38230 (EUR-3492.e) ^{14}C(d,n)^{15}N AND ^{15}N(d,n)^{16}O REACTIONS. Coppola, M.; Knitter, H.-H. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). Feb. 27, 1967. 16p. Dep.

Angular distributions of neutrons produced in the ^{14}C(d,n)^{15}N and ^{15}N(d,n)^{16}O reactions were measured at incoming deuteron energies of 1.3, 1.8, and 2.8 MeV and 1.0, 1.8, and 3.0 MeV, respectively, using a fast neutron time-of-flight spectrometer. Neutrons leading to the ground states and to some of the excited states of ^{15}N and ^{16}O were detected showing, in some cases, typical stripping patterns. (auth)

38231 (ISS-66/30) MEASUREMENT OF THE ANGULAR DISTRIBUTIONS OF PROTONS EXTRACTED FROM ^{12}C BY HIGH ENERGY ELECTRONS. Amaldi, U. Jr.; Campos Venuti, G.; Cortellessa, G.; De Sanctis, E.; Frullani, S.; Lombard, R.; Salvadori, P. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Sept. 12, 1966. 15p. Dep.

The angular distributions of protons extracted by 600-MeV electrons from the 1s and 1p shells of ^{12}C were measured, and the results were analyzed in terms of two simple nuclear potential wells. (auth)

38232 (ISS-67/14) SINGLE-PARTICLE WAVE FUNCTIONS OF THE ^{12}C NUCLEUS FROM ELASTIC AND QUASI-FREE ELECTRON SCATTERING. Ciofi Degli Atti, C. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). June 1967. 20p. Dep.

Using the Born approximation and the distorted-wave impulse approximation, the elastic form factor of the ^{12}C nucleus, the angular distributions, and the energy spectrum of the ^{12}C(e,e'p)^{11}B reaction were computed with harmonic oscillator and square-well wave functions. A comparison with recent experimental data was carried out, and the difficulty of reconciling the usual analyses of elastic and quasi-free scattering was pointed out. (auth)

38233 (JINR-P1-3372) OBRAZOVANIE GELIYA-8 PRI ZAKHVATE π^--MEZONOV YADRAMI UGLERODA, AZOTA I KISLORODA. (^{8}He Production in Negative Pion Capture by Carbon Nitrogen and Oxygen Nuclei). Batusov, Yu. A.; Bunyatov, S. A.; Sidorov, V. M.; Yarba, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 12p. (In Russian). Dep.

The events of ^{8}He production and decay in negative pion capture by carbon, nitrogen and oxygen were detected in photoemulsions. The relative probability of ^{8}He production by carbon nuclei is found to be $(8.0 \pm 2.5) \cdot 10^{-6}$, and by oxygen and nitrogen nuclei is $\sim 0.8 \cdot 10^{-6}$ and $\sim 2 \cdot 10^{6}$, respectively. The mass of ^{8}He was measured to M_{He^8} = (7482.5 ± 0.4) MeV. The mass excess is equal to M – A = (31.0 ± 0.4) MeV. (auth)

38234 (LA-DC-8856) p–p SCATTERING AT THE INTERFERENCE MINIMUM, AND APPLICATIONS OF THE ABSOLUTE VELOCITY GAUGE TECHNIQUE. Seagrave, John D. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 22p. (CONF-670629-2). Dep. CFSTI.

From Symposium on Light Nuclei, Few Body Problems, and Nuclear Forces, Brela, Yugoslavia.

The unique rationale of a recent experiment to determine the nuclear s-wave phase shift at the low-energy Coulomb-interference minimum is described together with the absolute velocity gauge instrumentation developed for this purpose, which made possible proton energy measurements to the accuracy of one part in 10^4 and the location of the interference minimum at 382.43 ± 0.20 keV. Energy determinations with the velocity gauge of the ^{19}F(p,$\alpha\gamma$)^{16}O resonance at 340.45 ± 0.04 keV, of the ^{27}Al(p,γ)^{28}Si resonance at 991.912 ± 0.043 keV, and of the ^{7}Li(p,n)^{7}Be threshold at 1880.617 ± 0.078 keV are compared with previous measurements that they supersede. The special property of the gauge response which permits differential energy transduction concurrently with absolute average energy measurement has not yet been exploited, and a number of applications are suggested. (auth)

38235 (ORNL-4128) REPRESENTATIVE RESULTS IN GRAPHICAL FORM FROM COMPUTER PRODUCTION RUNS OF THE LOW-ENERGY INTRANUCLEAR-CASCADE CALCULATION. Bertini, Hugo W.; Bishop, Barbara L.; Guthrie, Miriam P. (Oak Ridge National Lab., Tenn.). Aug. 1967. Contract W-7405-eng-26. 89p. Dep. CFSTI.

An extensive set of graphs which are meant to illustrate the mass and energy dependence of results that were selected from the output of computer production runs of a low-energy intranuclear-cascade calculation are presented. The nuclear reactions considered are those resulting from the interaction of neutrons and protons with energies from 50 to 400 MeV and π^+ and π^- with energies from 50 to 300 MeV with nuclei ranging from carbon to uranium. Plausibility arguments are given in an attempt to explain some of the results. (auth)

38236 PRODUCTION OF ENERGETIC He FRAGMENTS WITH 22 GeV/c PROTONS, STUDIED IN A BUBBLE CHAMBER. Egli, P. (Univ., Fribourg, Switzerland); Galliker, D.; Hugentobler, E.; Hahn, B. Helv. Phys. Acta, 40: 539-58(1967). (In German).

Energetic He-fragments produced by 21.4 GeV/c protons in C, Al, Cu, Ta, Pb, U-targets and in the bubble chamber liquid $CBrF_3$ are identified from range and by gap counting. Momentum- and angular distributions and the yield of these fragments in the energy interval of 275 to 600 MeV, in dependence on the atomic number of the target are reported. Possible mechanisms of formation of the fragments are discussed. (auth)

38237 FISSION-SPECTRUM-AVERAGED CROSS-SECTION MEASUREMENT FOR $^{9}Be(n,2n)$ REACTION. Green, L. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 10: 226(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38238 MEASURED NATURAL NEUTRON SOURCE IN $^{233}UO_2$–ZrO_2 AND $^{233}UO_2$–ThO_2. Emert, C. J.; Milani, S. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 10: 223(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38239 EXCITATION-FUNCTION STRUCTURE IN $^{16}O + ^{16}O$ SCATTERING. Siemssen, R. H.; Maher, J. V.; Weidinger, A.; Bromley, D. A. (Yale Univ., New Haven). Phys. Rev. Lett., 19: 369–72(Aug. 14, 1967).

Angular distributions and excitation functions for the elastic scattering of ^{16}O ions at 35 to 80 MeV by ^{16}O were measured. The data were analyzed using the optical-model code ABACUS. It was found that the gross structure of the excitation function can be reproduced by a potential model with a rather shallow potential. (D.C.W.)

38240 EXPERIMENTAL STUDY OF SPECIFIC FINAL-STATE DECAY MODES FOLLOWING PHOTOPARTICLE REACTIONS IN ^{16}O. Caldwell, John T.; Fultz, S. C.; Bramblett, R. L. (Univ. of California, Livermore). Contract W-7405-eng-48. Phys. Rev. Lett., 19: 447–9(Aug. 21, 1967). (UCRL-70515).

Transitions to specific final states populated following photoparticle reactions in ^{16}O were investigated by observing de-excitation gamma rays from the residual nuclei. The cross sections for the reactions (γ,α), (γ,n), and (γ,p) were studied in detail. Evidence was obtained for the basic validity of the single-particle, single-hole model as applied to ^{16}O. (D.C.W.)

38241 PHENOMENOLOGICAL α–α POTENTIAL AND THE GROUND STATE OF ^{8}Be. Ali, S.; Afzal, S. A. (International Atomic Energy Agency, Trieste, Italy). Nuovo Cim. (10), 50B: 355–8(Aug. 11, 1967).

It was shown that a phenomenological s-state α–α potential, the attractive part of which is constructed from G-wave scattering data and which is in keeping with the qualitative features demanded by a fundamental model of the α–α interaction, can provide a fairly adequate representation of the ground state of ^{8}Be. (D.C.W.)

38242 MEASUREMENT OF THE RMS RADIUS OF ^{12}C BY ELASTIC ELECTRON SCATTERING AT 53 MeV. Engfer, Roland; Tuerck, Dieter (Technische Hochschule, Darmstadt, Ger.). Z. Phys., 205: 90–5(1967).

Elastic electron scattering cross sections for carbon were measured relative to hydrogen. An analysis of the data with phase-shift calculations and a static charge distribution yields a model-independent rms radius of 2.42 ± 0.04 fm for the natural isotopic mixture of carbon. (auth)

38243 COUPLING BETWEEN (d,p) AND (d,n) CHANNELS AND THE SPECTROSCOPIC FACTOR IN (d,n) REACTIONS LEADING TO ANALOG STATES. Tamura, Taro (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev. Lett., 19: 321–4(Aug. 7, 1967). (ORNL-P-3186).

The spectroscopic factor of $^{9}Be(d,n)^{10}B$ leading to the T = 1 state is increased by about a factor of 2 by considering the $t \cdot T$ interaction and becomes consistent with shell-model predictions. (auth)

38244 CALCULATION OF PARTICLE–HOLE STATES IN THE 2s–1d SHELL. Engeland, T.; Ellis, P. J. (Univ. of Michigan, Ann Arbor). Phys. Lett., 25B: 57–60(Aug. 7, 1967).

A method is developed for calculating the positions of the particle-hole states in the sd shell. Configurations with up to 4-holes were included. Results are presented for the nuclei ^{16}O to ^{20}Ne. (auth)

38245 A DETAILED STUDY OF THE FIRST EXCITED STATE OF ^{8}Be. Cockburn, P. M.; Grant, I. S. (Univ. of Manchester, Eng.). Phys. Lett., 25B: 111–13(Aug. 7, 1967).

The E2/M1 amplitude ratio for the transition from the 17.6-MeV level in ^{8}Be to the broad first excited state is found to vary across the broad state. An explanation of the variation is suggested. (auth)

38246 DISTORTED-WAVE ANALYSIS OF THE $^{16}O(^{3}He,p)^{18}F$ REACTION AT 18 MeV. Puehlhofer, F.; Bock, R. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Lett., 25B: 117–19(Aug. 7, 1967).

The reaction $^{16}O(^{3}He,p)^{18}F$ was investigated at $E(^{3}He)$ = 18 MeV. The measurements are analyzed using a somewhat simplified distorted-wave calculation. Good agreement is found between the measured spectroscopic factors and those obtained from shell-model calculations. (auth)

38247 NUCLEAR MAGNETIC RESONANCE OF 20 ms ^{12}B. Sugimoto, K.; Nakai, K.; Matuda, K.; Minamisono, T. (Osaka Univ.). Phys. Lett., 25B: 130–1(Aug. 7, 1967).

NMR of ^{12}B was observed with ^{12}B implanted in metal by the reaction $^{11}B(d,p)^{12}B$ and polarized by the asymmetric β decay. The magnetic moment is determined to be $\mu(^{12}B) = +1.003 \pm 0.001$ nm. (auth)

38248 PHOTODISINTEGRATION OF ^{6}Li WITH HEAVY PARTICLE YIELD. Dzhibuti, R. I. (Inst. of Physics, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 45: 341–8(Feb. 1967). (In Russian).

Recent experimental results which contradict a pure α + d model for the ground state of the ^{6}Li nucleus consist of the particular spectrum of photodeuterons from the $^{6}Li(\gamma,d)^{4}He$ reaction and the high cross-section for the $^{6}Li(\gamma,^{3}H)^{3}He$ reaction at gamma energies of 20 to 30 MeV. The contradication between theory and experiment is not removed even on taking into account the interaction of the reaction products. In order to explain the disagreement, it is necessary to take into account the strong effect of configuration mixing due to nucleon associations. (TTT)

38249 FORM FACTOR FOR INELASTIC ELECTRON SCATTERING FROM THE 4.43-MeV LEVEL IN ^{12}C. Bouten, M. (Studiecentrum voor Kernenergie, Mol, Belg.); van Leuven, P. Ann. Phys. (N. Y.), 43: 421–7(July 1967).

The inelastic form factor for electron scattering from the 4.43-MeV level in ^{12}C is calculated, using the wave functions obtained from a Projected Hartree–Fock calculation. There is a considerable enhancement compared with the predictions from the simple shell-model. The agreement with experiment is good for not too large values of the momentum transfer. (auth)

38250 INVESTIGATION OF THE ANGULAR CORRELATION IN THE $^{12}C(p,2p)^{11}B$ REACTION AT 45.5 MeV. Richie, Kenneth E.; Wright, Byron T. (Univ. of California, Los Angeles). Contract Nonr-233(44). Phys. Rev., 159: 839–45(July 20, 1967).

The angular-correlation and energy distributions of the protons emitted from the $^{12}C(p,2p)^{11}B$ reaction at 45.5 MeV were measured with an absolute uncertainty of 10% and an angular resolution of ±2.5°. The data are compared with computer calculations based on a parameter study of the distorted-wave t-matrix approximation theory. Excellent agreement is obtained provided either the optical-model potential or the nuclear size is overestimated. (auth)

38251 PRECISION MEASUREMENTS OF GAMMA-RAY ENERGIES IN THE REGION FROM 2.3 TO 7.1 MeV. Chasman, C.; Jones, K. W.; Ristinen, R. A.; Alburger, D. E. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Phys. Rev., 159: 830–8(July 20, 1967). (BNL-11082).

Precision energy measurements were made on γ rays in the region from 2.3 to 7.1 MeV by means of Ge(Li) detectors and a grain-stabilized pulse-height analyzer system. The transitions studied include certain non-Doppler-broadened γ rays occurring in the reactions $^{12}C(^{3}He,p)^{14}N$, $^{14}N(d,p)^{15}N$, $^{14}N(d,n)^{15}O$, and $^{19}F(p,\alpha)^{16}O$ and the γ rays emitted in the radioactive decays of ^{12}B, ^{15}C, ^{14}O, and ^{16}N. In most cases energy calibrations were made with mixed sources and the extension to higher energies depended on the assumption of 1022.01 keV for the energy separation between full-energy-loss and two-escape peaks. The γ-ray energies in keV, with the nucleus from which they originate in parentheses, were determined to be the following: 2312.68 ± 0.10 (^{14}N), 2792.68 ± 0.15 (^{14}N), 4438.91 ± 0.31 (^{12}C), 5104.87 ± 0.18 (^{14}N), 5240.53 ± 0.52 (^{15}O), 5270.60 ± 0.46 (^{15}N), 5299.03 ± 0.43 (^{15}N), 6129.96 ± 0.46 (^{16}O), and 7117.02 ± 0.49 (^{16}O). (auth)

38252 PROPERTIES OF THE [15]-DIMENSIONAL SU(4) SUPERMULTIPLETS OF NEGATIVE-PARITY EXCITATIONS OF ^{16}O USING REALISTIC NUCLEAR FORCES. Barrett, B. R. (Stanford Univ., Calif.). Contract AF49(638)-1389. Phys. Rev., 159: 816–29(July 20, 1967).

Using particle-hole theory in the Tamm-Dancoff approximation and Wigner's SU(4) supermultiplet theory, the negative-parity excited states of ^{16}O are determined in terms of [15]-dimensional supermultiplets. Only the supermultiplets with total L = 1 are studied in detail, since they are the ones of importance with regard to the giant dipole resonance and to muon capture and electron scattering. Working in terms of nonmixing supermultiplets, it is found that each supermultiplet can be theoretically explained in terms of five parameters, while there are eight pieces of experimental data regarding each supermultiplet. Thus, the theory is overdetermined, and the parameters can be eliminated to obtain empirical sum rules, which can then be used to predict unobserved levels or to check the consistency of the calculation, independent

of the radial dependence of the nuclear force. Since there are two L = 1 supermultiplets, the mixing between them is also determined. Even after mixing, a sum rule is obtained for the T = 0 states. The realistic nuclear potentials of Tabakin and Brueckner, Gammel and Thaler are then used to calculate the L = 1 spectrum, so that it can be compared with the experimental spectrum and the sum-rule predictions. Theoretically, it is found that some of the parameters are small enough to be neglected with respect to the other parameters and that there is very little mixing between the two L = 1 supermultiplets. Both of these results allow one to obtain approximate sum rules. A total of five sum rules, of which four can be used for making empirical predictions of so-far unobserved experimental quantities, is obtained. The squared matrix elements for muon capture to the theoretically determined T = 1 levels are also calculated, and results similar to previous calculations are obtained. (auth)

38253 STRIPPING DISTORTIONS IN $^{11}B(d,p\gamma)^{12}B$ ANGULAR CORRELATIONS. Borden, A. P.; Ritter, R. C. (Univ. of Virginia, Charlottesville). Phys. Rev., 159: 875-84(July 20, 1967).

Angular correlations (p-γ) were measured in the $^{11}B(d,p\gamma)^{12}B$ reaction in order to determine how its distortions depend on deuteron energy and proton angle. Various proton angles were used, with E_d = 1.0, 1.8, 3.0, and 5.5 MeV. These parameters were chosen to systematically test predictions based on an application of the dispersion theory of direct nuclear reactions. The observed failure of the correlation anisotropy to increase as the stripping denominator D is reduced is most easily interpreted as a negative result for the application of this concept to the $^{11}B(d,p)^{12}B_{0.95}$ reaction. Trends in the behavior of the data are discussed. In addition, spectroscopic information about the captured neutron is deduced, and the excited state of ^{12}B is compared with shell-model theory. (auth)

38254 ENERGY LEVELS AND ELECTROMAGNETIC TRANSITIONS IN ^{15}N FROM THE $^{13}C(^3He,p\gamma)^{15}N$ REACTION. Phillips, G. W.; Young, F. C.; Marion, J. B. (Univ. of Maryland, College Park). Contract AT(40-1)-2098. Phys. Rev., 159: 891-908 (July 20, 1967). (ORO-2098-59).

Excited states of ^{15}N were studied by the $^{13}C(^3He,p\gamma)^{15}N$ reaction. Proton spectra were measured with a magnetic spectrometer at two angles for ^3He energies of 2 and 5 MeV. Excitation energies of 9.054 ± 0.004, 9.225 ± 0.003, 9.829 ± 0.004, and 10.072 ± 0.004 MeV were obtained for levels in ^{15}N. Electromagnetic branching ratios were measured for levels at 8.31, 8.57, 9.05, 9.16, 9.22, 9.76, 9.83, 9.93, 10.07, and 10.45 MeV. A comparison was made with theoretical branching ratios calculated from shell-model wave functions for levels at 8.31, 8.57, 9.05, and 9.93 MeV. Measured branching ratios for the first three of these levels agree with calculated ratios for shell-model levels of $J^\pi = \frac{1}{2}^+$, $\frac{3}{2}^+$, and $\frac{1}{2}^+$, respectively. Proton-γ angular-correlation measurements for levels at 9.05, 9.16, and 9.22 MeV indicate J = $\frac{3}{2}$ for the 9.16-MeV state, J = $\frac{1}{2}$ or $\frac{3}{2}$ for the 9.05-MeV level, and J = $\frac{3}{2}$ (90% probability) or J = $\frac{1}{2}$ (10% probability) for the 9.22-MeV level. (auth)

38255 ANALYSIS OF THE SCATTERING OF 46 MeV PROTONS FROM ^9Be AND ^{12}C. Satchler, G. R. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Nucl. Phys., A100: 497-536(1967). (ORNL-P-3078).

An analysis is made of the measurements of the elastic and inelastic scattering of 46-MeV protons by ^9Be and ^{12}C. The optical and collective models are used. There is considerable ambiguity in the optical parameters, and it was not found possible to obtain good fits to cross sections and polarizations simultaneously. Large quadrupole deformations were found for both $^{12}C(\beta_2 \approx 0.6)$ and $^9Be(\beta_2 \approx 1)$. The inelastic scattering from ^{12}C agrees best with deformation of both real and imaginary parts of the optical potential, while ^9Be shows a preference for real coupling. The 14.1-MeV level in ^{12}C is interpreted as the 4^+ rotational state, while the angular distribution for the 7.6-MeV 0^+ level is well described by double quadrupole excitation via the lowest 2^+. Interpretations are suggested for other inelastic transitions, including the excitation of spin and isospin oscillations. (auth)

38256 THE LOW-LYING LEVELS OF ^{18}O. Gruenbaum, L. (Technische Hochschule, Munich); Ganguly, N. K. Nucl. Phys., A100: 645-56(1967).

The low-lying levels of ^{18}O with even parity form a rotational band. Longitudinal and transverse cross sections are calculated for all levels up to 7 MeV excitation energy. The deformed state is a system of two protons and two neutrons in the deformed s, d orbitals above the core ^{14}C. Also matrix elements between spherical states are calculated using an effective charge ϵ_n = 0.4 for neutrons and 1.4 for protons. The effective charge is determined by fitting theoretical and experimental quadrupole moments of ^{17}O in the ground state. The effective charge in the calculation of the matrix elements between deformed states takes into account the ^{14}C core deformation. Too low transitions probabilities are found in comparison with experimental data. (auth)

38257 INFLUENCE OF ONE-PARTICLE STATES IN THE CONTINUUM ON THE LOW-LYING, NEGATIVE-PARITY STATES IN ^{17}O. Pfitzner, A. (Central Inst. for Nuclear Research, Rossendorf, Ger.). Nucl. Phys., A100: 673-82(1967).

Balashov's resonance approximation is used to calculate the level shifts and widths of the low-lying, negative-parity states in ^{17}O, assuming these states to be of 2p-1h structure. It turns out that the coupling to one particle continuum states is very important not only for the widths but also for the positions of most of the levels. The results prove to be very sensitive to the positions of the single-particle resonances in the (2p,1f) shell. (auth)

38258 PROTON ANGULAR DISTRIBUTION IN THE HIGH ENERGY $^{12}C(e,e'p)^{11}B$ REACTION. Amaldi, U. Jr.; Campos Venuti, G.; Cortellessa, G.; De Sanctis, E.; Frullani, S.; Lombard, R.; Salvadori, P. (Istituto Superiore di Sanita, Rome). Phys. Lett., 25B: 24-6(July 24, 1967).

The angular distributions of protons extracted by 600 MeV electrons from the 1s and 1p shells of ^{12}C were measured and the results analyzed in terms of two simple nuclear potential wells. (auth)

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Refer also to abstracts 37697, 38220, 38235, 38236, 38301, 38321, 38336, 38337, 38365, 38371, 38377, 38386, 38387, and 38422.

38259 (UCRL-17551) THE NUCLEAR MAGNETIC MOMENT AND BETA-DECAY ASYMMETRY OF ^{35}Ar. Calaprice, Frank Paul (California Univ., Berkeley. Lawrence Radiation Lab.). May 8, 1967. Contract W-7405-eng-48. 126p. Dep. CFSTI. Thesis.

The nuclear magnetic dipole moment of ^{35}Ar and the beta-decay asymmetry parameter for the mirror transition $^{35}Ar \rightarrow {}^{35}Cl$ (ground state) were measured by an atomic-beam technique. The angular distribution of electrons emitted from nuclei with polarization P is proportional to [1 + AP (v/c) cos θ], where v is the electron velocity and θ is the angle between the electron velocity and the spin polarization axis. ^{35}Ar decays to three levels of ^{35}Cl with the primary branch (93%) to the ground state. Because this transition involves no change in spin ($\frac{3}{2} \rightarrow \frac{3}{2}$), it is a mixture of both Fermi and Gamow-Teller radiations. The transitions to the two excited levels are pure G-T transitions. Since the asymmetries for pure G-T transitions are independent of the matrix elements, the ground-state asymmetry parameter can be determined by measuring the average asymmetry of the three transitions. To polarize the nuclei, a beam of ^{35}Ar atoms in the $^1S_0$ atomic state is formed by thermal effusion from a source at 77°K and passed through a conventional "Stern-Gerlach" magnet. The polarized beam then travels through a nuclear magnetic resonance coil, located in a uniform C field, and is eventually collected in a cylindrical glass bulb, where most of the ^{35}Ar nuclei decay. Although the atoms remain in the bulb long enough to make $\approx 10^6$ wall collisions, the nuclei retain their initial polarization. Two Geiger counters outside the bulb detect positrons emitted parallel and antiparallel to the polarization axis. The normalized difference betwen the count rates of the two counters is proportional to the asymmetry parameter A. Nuclear magnetic resonance in the C field is observed by detecting a partial reversal of the nuclear polarization in the bulb. The magnitude and sign of the nuclear magnetic moment μ are determined with a transverse oscillating rf field and a rotating rf field, respectively. The result, corrected for diamagnetic shielding, is μ = +0.633 ± 0.002 nm. The asymmetry parameter for the ground-state transition is A_0 = 0.196 ± 0.043. By use of this value, the ratio $\rho_\theta = C_A\langle\sigma\rangle/C_V\langle 1\rangle$ is calculated to be $\rho_\theta = -0.12 \pm 0.03$. The comparative half-life is calculated and, together with ρ_θ, is used to calculate the vector coupling constant, with the result $C_V(^{35}Ar) = 1.407 \pm 0.029 \times 10^{-49}$ erg-cm^3. Since the uncertainty in $C_V(^{35}Ar)$ due to ρ_θ is only 0.4%, a better measurement of the comparative half-life could yield a value of $C_V(^{35}Ar)$ comparable to the best results for pure Fermi decays. On assumption that $C_A/C_V \approx -1$, the Gamow-Teller matrix element is determined from ρ_θ to be $\langle\sigma\rangle \approx +0.12 \pm 0.04$. Both $\langle\sigma\rangle$ and μ are compared with predictions of nuclear models. Of the models considered, Nilsson's rotational model gives results in closest agreement with the experiment. (auth)

38260 EVIDENCE FOR PHOTOFISSION OF IRON. Fulmer, C. B. (Oak Ridge National Lab., Tenn.); Williams, I. R.; Hand-

ley, T. H.; Dell, G. F.; Blumberg, L. N. Contract W-7405-eng-26. Phys. Rev. Lett., 19: 522-3(Aug. 28, 1967). (ORNL-P-3308).

The yields of radionuclides in the exposure of Fe foils to 1.5-, 3-, and 5-GeV electron beams were measured. Relatively large yields of ^{32}P and ^{24}Na were observed; an explanation in terms of the photofission of iron by high-energy bremsstrahlung was proposed. (D.C.W.)

38261 THE SPIN OF THE 2.391 MeV LEVEL IN ^{23}Na. Richter, A.; Von Witsch, W. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys., A100: 683-8(1967).

An analysis of the fluctuating excitation function of the reaction $^{26}Mg(p,\alpha_3)^{23}Na$ in terms of the autocorrelation function yields a spin and parity $J^\pi = \frac{1}{2}^+$ for the third excited state in ^{23}Na. A fit of the energy averaged angular distribution according to Hauser and Feshbach as well as the (2J + 1)-dependence of the integrated cross section support also the $J^\pi = \frac{1}{2}^+$ assignment. (auth)

38262 UPPER LIMIT OF T NONCONSERVATION IN THE REACTIONS $^{24}Mg + \alpha \rightleftharpoons {}^{27}Al + p$. von Witsch, W.; Richter, A.; von Brentanto, P. (Max Planck Institut fuer Kernphysik, Heidelberg). Phys. Rev. Lett., 19: 524-6(Aug. 28, 1967).

Time-reversal invariance was tested via detailed balance in the compound-nuclear reactions $^{24}Mg + \alpha \rightleftharpoons {}^{27}Al + p$. The relative differential cross sections agree within the experimental uncertainties, leading to an estimated upper limit for the ratio of the T-nonconserving to the T-conserving reaction amplitudes of 2 to 4×10^{-3}. The same upper limit is found for the nuclear matrix elements which are odd with respect to time reversal. (auth)

38263 SCATTERING OF 750-MeV ELECTRONS BY CALCIUM ISOTOPES. Bellicard, J. B. (Stanford Univ., Calif.); Bounin, P.; Frosch, R. F.; Hofstadter, R.; McCarthy, J. S.; Uhrhane, F. J.; Yearian, M. R.; Clark, B. C.; Herman, R.; Ravenhall, D. G. Phys. Rev. Lett., 19: 527-9(Aug. 28, 1967).

The differential cross sections for the scattering of electrons by ^{40}Ca and ^{48}Ca at 750 MeV were measured in order to examine the energy dependence of the phenomenological charge distribution in terms of which previous data at 250 MeV were analyzed and to explore larger values of the recoil momentum q than was possible at that energy. It was found that the results at larger q are significantly different from those predicted by the phenomenological charge distribution. (D.C.W.)

38264 THE $^{31}P(n,p)$ REACTION AS A PROPOSED STANDARD METHOD FOR MEASUREMENT OF NEUTRON YIELDS FROM THE $D(d,n)^3He$ REACTION. Jessen, Phillip L.; Pierce, Kenneth C. (Kaman Nuclear, Colorado Springs, Colo.). Trans. Amer. Nucl. Soc., 10: 85(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

38265 EXPERIMENTAL STUDY OF 50-MeV PROTON ACTIVATION. Haffner, J. W. (North American Aviation, Inc., Downey, Calif.); Rusling, D. H.; Beever, E. R. Trans. Amer. Nucl. Soc., 10: 23(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

38266 ABSORPTION CROSS SECTION FOR ^{237}U. Cornman, W. R.; Hennelly, E. J.; Banick, C. J. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc., 10: 230-1 (June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

38267 ELECTRON BREMSSTRAHLUNG CROSS-SECTION MEASUREMENTS. Rester, D. H.; Dance, W. E. (Ling-Temco-Vought, Inc., Dallas, Tex.). Trans. Amer. Nucl. Soc., 10: 378 (June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

38268 PARAMETRIC FIT TO THE MANGANESE CROSS SECTION. Pearlstein, S.; Stephenson, T. E. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 10: 259-61(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11-15, 1967. See CONF-670602.

38269 OBSERVATION OF T = 2 LEVEL IN ^{24}Mg AS A COMPOUND-NUCLEUS RESONANCE. Riess, F.; O'Connell, W. J.; Heikkinen, D. W.; Kuan, H. M.; Hanna, S. S. (Stanford Univ., Calif.). Phys. Rev. Lett., 19: 367-9(Aug. 14, 1967).

The lowest T = 2 level in the self-conjugate nucleus ^{24}Mg has been observed as a sharp resonance in the once-T-forbidden capture reaction $^{23}Na(p,\gamma)^{24}Mg^*_{T=1}$ and in the twice-T-forbidden elastic scattering $^{23}Na(p,p_0)^{23}Na$. The assignment of J = 0 to this level at $E_x = 15.436 \pm 0.005$ MeV is confirmed by γ-γ correlation measurements. (auth)

38270 MEAN REACTOR CROSS SECTIONS FOR (n,p) REACTIONS ON SELENIUM. Deschuyter, M.; Hoste, J. (Ghent Univ.). Radiochim. Acta, 7: 90-5(June 1967).

The mean reactor cross sections for the reactions $^{74}Se(n,p)^{74}As$, $^{77}Se(n,p)^{77}As$, and $^{78}Se(n,p)^{78}As$ were determined experimentally by irradiation in a reactor. The interference of the ^{78}As impurity, which produces the same isotope through a (n,γ) reaction, was calculated. It was found that the fast component of the reactor spectrum, investigated with three different monitors, approximated a pure fission spectrum. The measured mean fission neutron cross sections are 16.2 ± 2.4, 0.16 ± 0.02, and 0.38 ± 0.06 mb for ^{74}As, ^{76}As, and ^{77}As, respectively, whereas the predicted values, according to Roy and Hawton, are 6.6, 0.7, and 1.7 mb. (auth)

38271 PROTON CAPTURE BY ^{23}Na YIELDING γ-RAYS FROM THE GIANT RESONANCE OF ^{24}Mg. Leslie, J. R.; Main, I. G. (Univ. of Liverpool). Nuovo Cim. (10), 50B: 389-91(Aug. 11, 1967).

Gamma spectra from the reaction $^{23}Na(p,\gamma)^{24}Mg$ at proton energies of 5 to 14 MeV were measured using a broad-range magnetic pair spectrometer. The excitation functions for the reactions $^{23}Na(p,\gamma_0)^{24}Mg$ and $^{23}Na(p,\gamma_1)^{24}Mg$ were also obtained, together with the ratio of the two yields. An attempt was made to identify 1^- states in ^{24}Mg. (D.C.W.)

38272 CROSS-SECTIONS OF SOME REACTIONS INDUCED IN BROMINE WITH 14.7-MeV NEUTRONS. Minetti, B.; Pasquarelli, A. (Univ., Turin. Istituti di Fisica Tecnica e Impianti Nucleari del Politecnico, Turin). Nuovo Cim. (10), 50B: 367-70(Aug. 11, 1967).

The cross sections for the reactions $^{79}Br(n,\alpha)^{76}As$, $^{79}Br(n,2n)^{78}Br$, $^{81}Br(n,\alpha)^{78}As$, $^{81}Br(n,p)^{81m}Se$, and $^{81}Br(n,2n)^{80}Br$ were measured by irradiating carbon tetrabromide powder with 14.7-MeV neutrons and counting the induced β and γ activities. (D.C.W.)

38273 LEVEL POSITIONS OF SOME Cu, Zn, Ga, AND Ge ISOTOPES. Brown, G.; Haigh, J. G. B.; Hudson, F. R.; MacGregor, A. E. (Univ. of Bradford, Eng.). Nucl. Phys., A101: 163-76 (1967).

New data on the positions of energy levels of $^{61,63,65}Cu$, $^{64,66}Zn$, ^{67}Ga, and $^{70,74}Ge$ are obtained using the (p,p') and (p,α) reactions on naturally occurring isotopes. Some of these data are used to obtain information on the variation of nuclear level density for neutron numbers N in the range $32 \leq N \leq 38$. (auth)

38274 ELASTIC AND INELASTIC PROTON SCATTERING FROM ^{46}Ti AND ^{48}Ti. Erramuspe, H. J. (Comision Nacional de Energia Atomica, Buenos Aires). Nucl. Phys., A101: 138-44(1967).

The dynamic deformation parameters β were measured for the separated isotopes ^{46}Ti and ^{48}Ti. Use was made of Buck's coupled-channel formalism for proton scattering. The results obtained were $\beta = 0.28$ for ^{46}Ti and $\beta = 0.26$ for ^{48}Ti. (auth)

38275 NUCLEAR ENERGY LEVELS OF ^{56}Fe FROM STUDIES OF THE (p,p'γ) REACTION. Hinrichsen, P. F. (Univ. of Pennsylvania, Philadelphia); Shapiro, M. H.; Van Patter, D. M. Nucl. Phys., A101: 81-108(1967).

The predominant decay modes of 12 levels in ^{56}Fe up to 4.0-MeV excitation were studied by particle-gamma coincidences from the $^{56}Fe(p,p'\gamma)$ reaction at $E_p = 6.0$ and 7.0 MeV and by Ge(Li) counter measurements of the γ-ray singles spectra. The gamma-ray decays of the levels at 3.12, 3.45, and 3.60 MeV indicated that these levels were doublets, and this was confirmed by high-resolution, magnetic spectrograph measurements. The level energies obtained in recent $^{56}Fe(p,p')$ spectrograph measurements and in γ-ray studies of the β decay of ^{56}Mn and ^{56}Co are compared. The branching ratios derived from Ge(Li) counter and conversion-electron studies of the ^{56}Co and ^{56}Mn β decays are summarized and compared with the present results. (auth)

38276 SCATTERING OF α PARTICLES WITH ENERGIES BETWEEN 12 AND 16 MeV ON ^{20}Ne, ^{24}Mg, ^{32}S, ^{40}Ar, ^{48}Ti, AND ^{58}Ni, EVEN-EVEN NUCLEI. Ivascu, M.; Semenescu, G.; Titirici, M.; Marincu, E. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 525-9(1967).

Angular distributions for alpha elastic and inelastic scattering by ^{20}Ne and for alpha inelastic scattering by ^{40}Ar, ^{24}Mg, ^{58}Ni, ^{32}S, and ^{48}Ti at 12 to 16 MeV were measured, using junction detectors, in order to study the reaction mechanism and the excitation of levels with unnatural parity. (D.C.W.)

38277 PHOTONUCLEAR REACTION YIELDS FROM ^{59}Co AT 35 MeV AND 54 MeV. Lichtblau, H.; Goldmann, A. (Technische Hochschule, Darmstadt, Ger.). Z. Phys., 205: 47-55(1967).

From measurements of gamma-ray activities, induced by ir-

radiating ^{59}Co with 35- and 54-MeV bremsstrahlung, the yields of the reactions (γ,2n), (γ,3n), (γ,4n), and (γ,x) ^{56}Mn relative to the yield of the reaction (γ,n) were determined. At both these energies the same value of 0.57 ± 0.02 was measured for the isomeric yield ratio $Y_m/(Y_m + Y_g)$ of ^{58}Co. Absolute yields were obtained by reference to cross-section data for the ^{12}C(γ,n) process. At high excitation energies only the reaction (γ,2n) was found to contribute appreciably to the photodisintegration of ^{59}Co. (auth)

38278 THE ^{34}S(p,γ)^{35}Cl REACTION AND ENERGY LEVELS OF THE ^{35}Cl NUCLEUS. Darwish, D. A. E.; El-Kateb, S. A.; El-Nadi, L. M.; Badawy, Omar E.; Lvov, A. N. (Atomic Energy Establishment, Cairo). Z. Phys., 205: 8-24(1967).

The reaction ^{34}S(p,γ)^{35}Cl was investigated in the proton energy range from 1.89 up to 2.54 MeV. Twenty nine resonances are observed in the yield curve of this reaction. Gamma-ray spectra for ten resonances are studied, and decay schemes for the corresponding resonance states are proposed. The possibility of a new level either at 3.95 ± 0.05 or 4.45 ± 0.05 MeV in ^{35}Cl is discussed. (auth)

38279 LARGE ANGLE ALPHA PARTICLE SCATTERING FROM THE 3$^+$ UNNATURAL PARITY STATES IN MAGNESIUM. Vincent, J. S.; Boschitz, E. T.; Priest, J. R. (Lewis Research Center, Cleveland, Ohio). Phys. Lett., 25B: 81-3(Aug. 7, 1967).

The differential cross sections for inelastic alpha particle scattering to large angles from 3$^+$ states in ^{24}Mg and ^{26}Mg at 42 MeV show a clear diffraction type of pattern and pronounced enhancement compared with forward angles. (auth)

38280 PROPERTIES OF SOME ^{25}Mg ENERGY LEVELS. McCallum, G. J.; Sowerby, B. D. (Australian National Univ., Canberra). Phys. Lett., 25B: 109-11(Aug. 7, 1967).

The following information was obtained on ^{26}Mg: the branching ratios of the 3rd to 8th excited states inclusive; the multipole mixing ratios of the 1.962 → 0, 1.962 → 0.976 and 3.399 → 1.611 MeV transitions; and the spins of the 1.611, 2.736, and 3.399 MeV levels. (auth)

38281 A NEW LEVEL IN ^{24}Na AT 1.51 MeV. Jahr, R.; Pfleger, J. A. H.; Zell, H. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Lett., 25B: 113-15(Aug. 7, 1967).

A level at E_x = 1508 ± 10 keV was observed in the reaction ^{26}Mg(d,α)^{24}Na at E_d = 11.8 MeV. A comparatively high spin of the new level is suggested. (auth)

38282 OPTICAL PUMPING OF SHORT-LIVED BETA EMITTERS. Besch, H. J.; Koepf, U.; Otten, E. W. (Univ., Heidelberg). Phys. Lett., 25B: 120-1(Aug. 7, 1967).

Sodium-21 nuclei, produced by the reaction ^{20}Ne(d,n), were polarized by means of optical pumping in the atmosphere of the target. An asymmetry of 0.3% of the subsequent β decay was found. Radio-frequency transitions between hyperfine levels of the atomic ground state of ^{21}Na were detected by a decrease of the decay asymmetry. (auth)

38283 PHONON FREQUENCY DISTRIBUTION OF VANADIUM. Page, D. I. (Chalk River Nuclear Labs., Ont.). Proc. Phys. Soc. (London), 91: 76-85(May 1967).

Measurements of neutrons scattered inelastically from vanadium were made, and absolute cross sections were determined over a range of energy and momentum transfers of 0 to 50 MeV and 1 to 12 Å^{-1}, respectively. A frequency distribution of the normal modes of vibration in vanadium is evaluated from these data. Peaks are observed at energy transfers of 8, 20.5, 25.5, and 28.5 MeV (equal to 1.9, 4.9, 6.1, and 6.9 × 10^{-12} sec^{-1}). Neutron spectra were calculated using this distribution, and good agreement was obtained with experimental data. A comparison is made with the frequency distributions of niobium and tantalum. (auth) (UK)

38284 POSITRON EMISSION FROM ^{36}Cl. Pierson, William R. (Ford Motor Co., Dearborn, Mich.). Phys. Rev., 159: 951-2(July 20, 1967).

Positron emission in the decay of 3.08 × 10^5-yr ^{36}Cl was verified. The intensity is 0.00166 ± 0.00011%, and the energy is 115 ± 18 keV. (auth)

38285 NUCLEAR ENERGY LEVELS OF ^{52}Cr, ^{55}Mn, AND ^{66}Zn. Katsanos, A. A.; Huizenga, J. R. (Argonne National Lab., Ill. Univ. of Chicago). Phys. Rev., 159: 931-8(July 20, 1967).

Nuclear energy levels of ^{52}Cr, ^{55}Mn, and ^{66}Zn were determined by analyses of particles from the ^{52}Cr(p,p')^{52}Cr, ^{55}Mn(p,α)^{52}Cr, ^{55}Mn(p,p')^{55}Mn, ^{66}Zn(p,p')^{66}Zn, and ^{69}Ga(p,α)^{66}Zn reactions with a broad-range single-gap magnetic spectrograph. In the first 6.3 MeV of excitation energy, 66 levels of ^{52}Cr; in the first 3.9 MeV, 62 levels of ^{55}Mn; and in the first 4.8 MeV, 74 levels of ^{66}Zn were resolved and investigated. (auth)

38286 COULOMB EXCITATION OF LOW-LYING EXCITED STATES IN ^{45}Sc. Blaugrund, A. E.; Holland, R. E.; Lynch, F. J. (Argonne National Lab., Ill.). Phys. Rev., 159: 926-30(July 20, 1967).

Properties of the first excited state of ^{45}Sc at 12.4 keV and the second excited state at 376 keV were measured. A limit on the admixture of E3 radiation in the predominantly M2 decay of the first excited state was set by looking for E3 Coulomb excitation of this state with ^{35}Cl ions. The result is that B(E3, $\frac{1}{2}^- \rightarrow \frac{3}{2}^+$) ≤ 105 e^{2}fm^6 = 2.7 single-particle units. The mean lifetime has been remeasured as τ = 0.470 ±0.006 sec. The K-conversion coefficient was measured to be 580 ± 120. The energy of the second excited state was determined to be 375.5 ± 1.0 keV. It was found to decay primarily to the first excited state with a branching ratio of 10.8 ± 0.5. The reduced matrix element for Coulomb excitation of the second excited state was measured to be B(E2, $\frac{1}{2}^- \rightarrow \frac{3}{2}^-$) = 60.5 ± 10 e^{2}F^4. (auth)

38287 INELASTIC DEUTERON SCATTERING AND (d,p) REACTIONS FROM ISOTOPES OF TITANIUM. IV. ^{48}Ti(d,p)^{49}Ti. Barnes, P. D. (Yale Univ., New Haven); Comfort, J. R.; Bockelman, C. K.; Hansen, Ole; Sperduto, A. Contracts AT(30-1)-2098; AT(30-1)-3223. Phys. Rev., 159: 920-6(July 20, 1967).

Levels below 6.2 MeV of excitation were observed in the ^{48}Ti(d,p)^{49}Ti reaction at an incident energy of 6.0 MeV. The over-all energy resolution was 15 keV. Differential cross sections for the more intense proton groups were measured. A distorted-wave analysis yielded l_n values and spectroscopic strengths for 24 of the (d,p) transitions. A sum-rule analysis indicates that most of the $1f_{\frac{7}{2}}$ and 2p strengths were located whereas only fractions of the $1f_{\frac{5}{2}}$, $1g_{\frac{9}{2}}$, $2d_{\frac{5}{2}}$, and $3s_{\frac{1}{2}}$ strengths were found. A level scheme for ^{49}Ti is proposed, and the ^{49}Ti level structure is compared to theoretical predictions. It is pointed out that the level structure near 2.5 MeV in ^{49}Ti is not clear experimentally, though several states important for the comparison with theory occur in this region. A set of Q values is proposed for the various Ti(d,p) reactions. (auth)

38288 BETA DECAY OF ^{56}Mn AND ^{56}Co. Chasman, C.; Ristinen, R. A. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Phys. Rev., 159: 915-19(July 20, 1967). (BNL-10807).

Gamma transitions following the decay of ^{56}Mn to ^{56}Fe were investigated with particular attention given to weak transitions following hindered β decays. Two such transitions were found, one to the 2.085-MeV state in ^{56}Fe (log ft = 8.7 ± 0.2) and the other to the 3.445-MeV state (log ft = 6.0 ± 0.2). Precision γ-ray measurements were made both to corroborate the decay scheme and to provide γ-ray calibration energies. The decay of ^{56}Co to ^{56}Fe was similarly investigated; several new transitions were found. Precision γ-ray energies are reported. (auth)

38289 EXCITED LEVELS IN ^{61}Co FROM THE DECAY OF ^{61}Fe. Gujrathi, S. C.; Mukherjee, S. K. (Saha Inst. of Nuclear Physics, Calcutta). Phys. Rev., 159: 909-14(July 20, 1967).

Irradiation of enriched ^{64}Ni samples with the 14.8-MeV neutrons was found to produce an activity of 5.8 ± 0.5-min half-life which was assigned to ^{61}Fe. The assignment was confirmed by following the decay of the iron activity separated from the irradiated samples of Spec-pure nickel. The scintillation spectrometer studies showed that γ rays of energies 130, 170, 230, 295, 400, 1010, and 1180 keV and β groups of maximum energies 2800 ± 100 (31%), 2630 ± 100 (54%), and 2500 ± 100 (13%) keV were decaying with a half-life of 5.8 min. The γ-γ and the β-γ coincidence studies were performed which showed the existence of excited levels at 1010, 1180, 1305, and 1410 keV in ^{61}Co. A decay scheme of ^{61}Fe is proposed, and the results are discussed in the light of the single-particle shell model. (auth)

38290 SPALLATION REACTIONS IN ISOTOPICALLY ENRICHED TARGETS. Chackett, K. F. (Rutherford High Energy Lab., Chilton, Eng.); Chackett, G. A. Nucl. Phys., A100: 633-44 (1967).

Yields of ^{42}K and ^{43}K were measured in spallation reactions at 590 MeV and at 7 GeV in isotopically enriched targets from ^{58}Ni to ^{68}Zn. The results are correlated with other recent measurements in the development of a new empirical spallation-yield formula which takes into account the isotopic composition of the target. A practical example of the use of this formula is discussed. (auth)

38291 CHARGE DEPENDENCE OF NUCLEAR FORCES IN ΔJ = 0, ΔT = ±1 BETA DECAYS. Yap, C. T. (Univ. of Sussex, Brighton, Eng.). Nucl. Phys., A100: 619-32(1967).

By assuming the validity of the conserved vector current theory, the Fermi nuclear matrix elements M_F for the beta decays of ^{19}F, ^{41}Ar, ^{44}Sc, ^{52}Mn, and ^{56}Co which violate the ΔT = 0 selection rule are calculated theoretically in the jj-coupling, shell model. In these

calculations, M_F is obtained by considering a short-range, charge-dependent, internucleon potential in addition to the usual Coulomb potential. Experimental values of M_F have been obtained by measuring the asymmetry parameter A appearing in the β-γ circular polarization correlation. Comparison between the theoretical and experimental values yields the result that the deviation of nuclear forces from exact charge independence is about a few percent, while the deviation from charge symmetry is consistent with a value an order of magnitude smaller. If the conserved vector current theory is not valid, additional contributions to the Fermi nuclear matrix elements can arise from mesonic exchange currents. It is noted that such effects could be as large as those due to charge-dependent forces and would therefore cloud the above interpretation. (auth)

38292 A NEW ACTIVITY ^{52}Ti. Morinaga, H. (Tokyo Univ.); Miyano, K.; Fujikawa, K.; Chiba, R.; Ebisawa, K.; Kawai, N. Phys. Lett., 25B: 22-3(July 24, 1967).

A new β^- activity is discovered with a half life of 1.7 ± 0.1 min which is ascribed to ^{52}Ti, formed through the ^{50}Ti(t,p)^{52}Ti reaction. Two γ rays in coincidence, with E_γ = 125 and 17 keV, are observed. The β^- end-point is 1.8 MeV. (auth)

38293 PARTICLE-HOLE STATES IN ^{41}Ca AND ANALOG STATES OF ^{41}K, OBSERVED IN THE ^{42}Ca(^{3}He,α) REACTION. Lynen, U.; Bock, R.; Santo, R.; Stock, R. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Lett., 25B: 9-12(July 24, 1967).

The level structure of ^{41}Ca was investigated using the ^{42}Ca(^{3}He,α) ^{41}Ca reaction at E(^{3}He) = 18 MeV. Evidence for particle-hole components in ^{41}Ca and ^{42}Ca is found, in particular by the detection of $^1/_2^-$ excited states in ^{41}Ca. Several analogue states of levels in ^{41}K are identified. (auth)

38294 NUCLEAR TABLES. PART 2. NUCLEAR REACTIONS. VOL. 2. THE ELEMENTS FROM ALUMINUM TO SULPHUR. Kunz, W.; Schintlmeister, J. Oxford, Pergamon Press, 1967. 290p. UK 261s.

Includes tables.

A compilation of the available information on nuclear reactions of Al, Si, P, and S is presented. (UK)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 36058, 37667, 38235, 38236, 38260, 38265, 38267, 38273, 38377, 38406, and 38410.

38295 (AAEC/E-164) LUBRA: A CODE TO CALCULATE POINT AND GROUP CROSS SECTIONS, EFFECTIVE RESONANCE INTEGRALS AND DOPPLER COEFFICIENTS FOR RESONANCE ABSORBERS IN HOMOGENEOUS REACTORS, USING BREIT-WIGNER SINGLE-LEVEL RESONANCE PARAMETERS. Kletzmayr, E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Oct. 1966. 102p. Dep.

The LUBRA complex of codes is designed to produce point cross sections, infinitely dilute resonance integrals, effective resonance integrals based on the different approximations presently available and optionally modified to include particle size effects, Doppler coefficients also based on the various models, and group averaged cross sections, using Breit-Wigner single-level resonance parameters and other basic data only. The complex currently comprises five individual programs coded in FORTRAN IV for an IBM 7040 computer and linked together by a specialized monitor system to permit the use of LUBRA as a single entity. (auth)

38296 (ANL-7330) ^{250}Cm PRODUCTION IN A HIGH-FLUX REACTOR. Diamond, H.; Stevens, C. M.; Metta, D. N.; Lerner, J. L.; Kelly, F. R. (Argonne National Lab., Ill.). May 1967. Contract W-31-109-eng-38. 6p. Dep. CFSTI.

Curium-250 was observed in a neutron bombardment whose nvt was ~4×10^{22} n/cm^2. It is shown that the principal source of ^{250}Cm in high-flux reactors is neutron capture by ^{249}Cm. The ^{249}Cm capture cross section is estimated from the available information. (auth)

38297 (BMwF-FBK-67-59) ZUR STRUKTUR DES VANADIUM 48. (On the Structure of ^{48}V). Flender, H. W. (Bonn Univ. (West Germany). Institut fuer Strahlen und Kernphysik). June 1967. 95p. (In German). Dep.

The g-factor of the 304-keV state of ^{48}V was determined by observing the rotation of the 116 keV- 305 keV $\gamma\gamma$ angular correlation in strong external magnetic fields. Liquid sources as well as ^{48}Cr sources embedded in a lattice of metallic copper were used for these measurements. Within the limits of error the same rotation was found for both sources. The result g = +0.188 ± 0.017 disagrees with the predictions of the $f_{7/2}$-model of McCullen et al. but may be explained in the Nilsson model. (auth)

38298 (JINR-P6-3348) O TSEPOCHKE RASPADA ^{140}Nd → ^{140}Pr → ^{140}Ce. (On the Decay Chain of ^{140}Nd → ^{140}Pr → ^{140}Ce). Abesalashvili, L. N.; Zhelev, Zh.; Kalinnikov, V. G.; Liptak, Ya.; Nazarov, U.; Urbanets, Ya. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1967. 24p. (In Russian). Dep.

Gamma-ray and conversion-electron spectra of ^{140}Pr($T_{1/2}$ = 3.4 min), which was in equilibrium with ^{140}Nd($T_{1/2}$ = 3.3 d), were studied. The mass difference of the nuclides ^{140}Pr and ^{140}Ce(ΔM = 3388 ± 6 keV) is specified. The data on the multipolarities of a number of γ transitions in ^{140}Ce are confirmed. The data on the ^{140}Ce level populations from the ^{140}Pr decay are presented. The value of the given matrix element of a monopole electrical transition in ^{140}Ce (ρ = 0.12) is determined. The nature of the ^{140}Ce is discussed. (auth)

38299 (JINR-P7-3423) O SVOISTVAKH IZOTOPA ^{256}102. (On the Properties of Isotope ^{256}102). Flerov, G. N.; Demin, A. G.; Druin, V. A.; Lobanov, Yu. V.; Mikheev, V. L.; Polikanov, S. M.; Shchegolev, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1967. 8p. (In Russian). Dep.

The isotope ^{256}102 was synthesized in the nuclear reactions ^{242}Pu(^{18}O,4n) and ^{238}U(^{22}Ne,4n) using the 310 cm JINR cyclotron. In accordance with the previously performed measurements the alpha-particle energy of ^{256}102 was found to be 8.43 ± 0.03 MeV. The half-life was improved and was found to be 3.7 ± 0.5 sec. It is concluded that the partial spontaneous fission half-life of ^{256}102 of about 1500 sec, found previously, is only the lower boundary of this half-life. (auth)

38300 (NASA-TM-X-1403) SEARCH FOR THE γ-2γ PROCESS IN NUCLEAR ELECTROSTATIC FIELDS. Roberts, William K.; Liu, David C. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Aug. 1967. 27p. CFSTI.

An experiment designed to detect the γ-2γ process (an interaction of a photon with an electric field with the subsequent emission of two photons) was performed. A geometry was chosen in which the secondary gamma rays were emitted at an angle of 90° to each other and at an angle of 135° to the projection of the incident gamma-ray arrival direction. Measurements were performed by using lead and copper targets and 1.33-MeV (2.14×10^{-13} J) primary gamma rays. An energy-summing time-coincidence technique was employed to detect pairs of secondary gamma rays. Statistically significant upper limits of 960 nanobarns per steradian squared per MeV (6×10^{-22} m^2/(sr^2)(J)) for the differential cross section in lead and 146 nanobarns per steradians squared per MeV (0.915×10^{-22} m^2/(sr^2)(J)) in copper were obtained, compared with theoretical values of 0.8 and 0.1 nanobarn per steradian squared per MeV (0.5×10^{-24} and 0.062×10^{-24} m^2/(sr^2)(J)), respectively, for this geometry. Although the upper limits established were not a rigorous test of the theory, information gained indicates that cross sections in the range of theoretical predictions can be measured with suitable improvements of the experimental technique. These improvements are discussed. (auth)

38301 (RLO-1388-13) ANNUAL REPORT [ON NUCLEAR PHYSICS], JUNE 1966. (Washington Univ., Seattle. Nuclear Physics Lab.). Sept. 1966. Contract AT(45-1)-1388. 120p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Nuclear research and technical developments conducted at the Nuclear Physics Laboratory at the University of Washington during the year ending June 15, 1966, are reviewed. Investigations reported include the following: proton scattering from isobaric analog states in Pb isotopes; spectra of inelastic alpha particles scattered from Sn, Au, and U; spin and parity measurement of an isobaric analog resonance in ^{124}Sn(p,p); elastic and inelastic scattering of α particles from ^{48}Ca at 42 MeV; phase correlations in α particle inelastic scattering by ^{24}Mg; inelastic excitation of unnatural parity states in ^{24}Mg; the ^{63}Cu(d,^{3}He)^{62}Ni reaction in the region of 3 MeV of excitation; study of the single-particle nature of the low-lying states of ^{89}Sr and ^{89}Y from the ^{90}Zr(d,^{3}He)^{89}Y* and ^{89}Y(d,^{3}He)^{89}Sr* reactions at 21 MeV; identification of proton states in ^{209}Bi using the ^{208}Pb(α,t)^{209}Bi reaction; variation of the width of the first excited state of ^{9}Be which depends upon the reaction by which the level is observed; the ground state configuration of ^{41}Ca and a survey of the energy levels of ^{41}Ca by the ^{40}Ca(d,t)^{41}Ca reaction; (α,^{6}Li) and (α,^{7}Li) reactions on ^{11}B, ^{15}N, and ^{19}F; (d,^{6}Li) reactions at 21 MeV on ^{12}C, ^{16}O, ^{19}F, ^{24}Mg, ^{32}S, ^{48}Ca, and ^{58}Ni; study of time reversal invariance in the inverse reactions ^{24}Mg + d ⇌ ^{25}Mg + p; gamma ray polarization measurements (α,$\alpha'\gamma$) reactions; the double gamma decay of ^{72}Ge; the distribution function of residual angular momentum in decaying compound nuclei; angular and intensity distributions of rotational E2 gamma rays following

(α,3n) reactions; measurements of photons produced in nuclear bombardments with high-energy protons, ^{3}He, and α particles; proton-gamma angular correlations and spin flip; angular correlations in (d,pf) reactions; angular distribution of ^{18}O fragments from the ^{28}Si(α,^{16}O)^{16}O reaction at 42 MeV; angular distributions from the ^{16}O(^{16}O,^{4}He)^{28}Si reaction; spectral fluctuations in the ^{27}Al(d,p) reactions proceeding to the continuum; competition between neutron emission and fission at moderate excitation energies for ^{252}Cf; channel analysis of cross sections and anisotropies for neutron-induced fission of ^{234}U; doubly charged particle emission during nuclear fission; application of an on-line computer system for real-time acquisition and processing of data for nuclear physics experiments; particle identification by pulse shape discrimination; liquid-nitrogen-cooled solid-state detectors; fabrication of Li-drifted silicon detectors; methods for preparation of targets; and accelerator research and development. (S.F.L.)

38302 (TID-23909) NUCLEAR LEVELS OF ^{162}Dy. Baecklin, A.; Suarez, A.; Schult, O. W. B.; Maier, B. P. K.; Gruber, U.; Shera, E. B.; Hafemeister, D. W.; Shelton, W. N.; Sheline, R. K. (Forskningradens Laboratorium, Studsvik (Sweden)). 1967. 65p. (LF-18; LA-DC-8526). Dep. CFSTI.

The nuclear level scheme of ^{162}Dy was studied utilizing a variety of experimental methods. From the reaction ^{161}Dy(n,γ)^{162}Dy, low-energy gamma-ray transitions were measured between 40 and ≈1350 keV with a bent crystal spectrometer, and the (n,e$^-$) conversion-electron spectrum was investigated in the energy range between 160 and 1300 keV with a double-focusing beta spectrometer. Altogether, some 160 transitions were found, and multipolarities were assigned for about 50 of these. High-energy gamma rays from neutron capture in ^{161}Dy were measured in the energy region between 4.9 and 8.2 MeV with a Ge(Li) detector operated in the pair mode; 49 transitions were found. Furthermore, the reactions ^{162}Dy(p,p'), ^{162}Dy(d,d'), ^{161}Dy(d,p), and ^{163}Dy(d,t) were studied at 12-MeV beam energy, using a broad-range magnetic spectrograph. Combining the results of all these experiments, a level scheme containing 90% of the intensity of the low energy (n,γ) spectrum of ^{162}Dy was constructed consisting of the following levels: the ground-state rotational band up to the 8$^+$ level; the K = 2$^+$ (gamma vibrational) band at 888.22 keV including all members up to the possible 7$^+$ state; the K = 2$^-$ octupole vibrational or [411↑ − 523↑] band with the band head at 1148.29 keV and including members up to the tentative 5$^-$ and 6$^-$ levels; the K = 4$^+$[521↑ + 523↓] band at 1535.89 keV containing members up to the 6$^+$, and possibly the 7$^+$ level; a K = 0$^-$ band (probably octupole) with 1$^-$ and 3$^-$ members at 1275.4 keV and 1357.0 keV, and possibly the 5$^-$ member at 1520 keV; a tentative K = 0$^+$ band with 2$^+$ and 4$^+$ members at 1206.1 and 1390.3 keV, suggesting that 0$^+$ level at 1127 keV; the [521↑ − 523↓]K = 1$^+$ band at 1745 keV containing states up to the 6$^+$ level; the K = 3$^-$[642↑ + 521↓] band at 1770 keV containing levels up to the 6$^-$ member and finally the K = 2$^-$[642↑ − 521↓] band at 1866 keV containing levels up to the 5$^-$ state. Other unassigned levels were found above 1.4 MeV in the (d,p), (d,t), and high-energy (n,γ) measurements. The agreement between experimental and calculated cross sections for the (d,t) and (d,p) reactions was found to be good for the [521↑ ± 523↓] and the [642↑ ± 521↓] states, but not so good for the [642↑ ± 523↓] states. The neutron binding energy in ^{162}Dy was determined to be 8192.8 ± 3 keV. (auth)

38303 MEASUREMENT OF THE THERMAL ABSORPTION CROSS SECTIONS OF Lu, Eu, AND Yb AND DETERMINATION OF THE NEUTRON TEMPERATURE IN THE THERMAL COLUMN OF THE ROSSENDORF RESEARCH REACTOR RFR. Albert, D.; Hagner, J.; Huettel, G. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie, 10: 25-6(Jan. 1967). (In German).

The neutron temperature in the thermal column of the RFR was calculated to be 41 ± 6°C for a reactor power of 2 Mw and 46 ± 9°C for a reactor power of 4 Mw. The thermal absorption cross sections were then measured for Eu as 4750 ± 40, for ^{151}Eu as 9350 ± 110, for ^{176}Lu as 1980 ± 50, and for ^{168}Yb as 3080 ± 340 b. The results were compared with those obtained by other investigators. (J.S.R.)

38304 DECAY OF ^{124}I. Ruan, Jian-zhi; Inoue, Hikaru (Osaka Univ.). J. Phys. Soc. Jap., 23: 481-9(Sept. 1967).

The decay of ^{124}I was investigated with beta spectrometers and scintillation spectrometers by using carrier-free source produced by the reaction ^{121}Sb(α,n)^{124}I. The intensity ratio of the 1.54-MeV beta component to the 2.15-MeV component was obtained to be 1.07. Internal conversion ratios for the 604-keV gamma transition are K/L = 7.3 ± 0.4 and (M + N)/L = 0.26 ± 0.07. Internal conversion coefficients were determined to be 3.8 ± 0.6 × 10^{-3}, 2.5 ± 0.4 × 10^{-3}, 7.9 ± 1.5 × 10^{-4}, 3.3 ± 0.8 × 10^{-4}, 2.9 ± 0.7 × 10^{-4}, 2.1 ± 0.4 × 10^{-4}, and 2.1 ± 0.8 × 10^{-4} for gamma transitions of 0.604, 0.72, 1.32, 1.37, 1.52, 1.69, and 2.08 MeV, respectively. The coefficient $A_2(W)$ in the directional correlation function $W(\theta,W) = 1 + A_2(W)P_2(\cos\theta)$ was measured for the 2$^-$(1.54 MeV β)2$^+$(0.604 MeV γ)0$^+$ cascade. The result is discussed on the basis of the ξ approximation, the modified B_{ij} approximation, and a more accurate method. (auth)

38305 SIMULTANEOUS MEASUREMENTS OF THE ^{233}U FISSION AND CAPTURE CROSS SECTIONS. Weston, L. W. (Oak Ridge National Lab., Tenn.); Gwin, R.; de Saussure, G.; Ingle, R. W.; Fullwood, R. R.; Hockenbury, R. W. Trans. Amer. Nucl. Soc., 10: 220-1(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38306 URANIUM-233 CROSS SECTIONS AS DETERMINED USING NEUTRONS FROM A NUCLEAR DETONATION. Bergen, D. W. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 10: 221(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38307 EVALUATION OF ^{233}U CROSS SECTIONS. Drake, M. K. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 221-2(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38308 RESONANCE ABSORPTION INTEGRALS MEASURED BY REACTIVITY TECHNIQUES. Rogers, J. W.; Scoville, J. J.; (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc., 10: 259(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38309 RESONANCE INTEGRALS OF RHENIUM FOR A WIDE RANGE OF SAMPLE SIZES. Shook, Donald F.; Pierce, Clarence R. (Lewis Research Center, Cleveland). Trans. Amer. Nucl. Soc., 10: 261-2(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38310 IMPLICATIONS ABOUT RESONANCE PARAMETERS IN ^{186}W FROM DOPPLER MEASUREMENTS AS A FUNCTION OF THICKNESS. Beller, L. S. (Atomics International, Canoga Park, Calif.); Latham, D. W.; Otter, J. M. Trans. Amer. Nucl. Soc., 10: 262-3(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38311 EFFECTIVE RESONANCE INTEGRALS AND DOPPLER COEFFICIENTS OF THICK SAMPLES OF NATURAL AND SEPARATED TUNGSTEN. Royden, H. N.; Paschall, R. K.; Otter, J. M.; Carpenter, S. G. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 10: 263-4(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38312 INFINITE DILUTION AND SHIELDED RESONANCE INTEGRALS OF ^{238}U. Baumann, N. P.; Halford, J. D.; Pellarin, D. J. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc., 10: 264(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38313 DOPPLER-BROADENED LINE-SHAPE FUNCTIONS FOR P-WAVE RESONANCES. Dyos, M. W. (Westinghouse Electric Co., Cheswick, Pa.). Trans. Amer. Nucl. Soc., 10: 264-5(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38314 CALCULATION OF THE RESONANCE INTEGRAL OF ZIRCONIUM AND COMPARISON WITH EXPERIMENTAL RESULTS. Steen, N. M.; Harris, D. R. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 10: 265-6(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38315 THERMAL-NEUTRON CAPTURE GAMMA-RAY SPECTRA OF ZIRCONIUM AND NIOBIUM. Orphan, V. J.; Rasmussen, N. C. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 10: 225-6(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38316 IMPROVED NEUTRON CROSS SECTION FOR FORMATION OF 60-DAY HALF-LIFE ^{124}Sb. Plumlee, K. E. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 226-7(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38317 THERMAL-NEUTRON CROSS SECTIONS AND RESONANCE INTEGRALS FOR TRANSURANIUM ISOTOPES. Prince, A. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 10: 228(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38318 CRYSTALLINE EFFECTS ON THE DOPPLER-BROADENED CROSS SECTION AND RESONANCE INTEGRALS OF URANIUM IN A UO_2 LATTICE. Adkins, C. R. (Carnegie Inst. of Tech., Pittsburgh); Persiani, P. J.; Hwang, R. N. Trans. Amer. Nucl. Soc., 10: 228-9(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38319 TEMPERATURE DEPENDENCE OF EPITHERMAL FISSION IN $^{235}UO_2$ RODS. Schoenig, F. C. Jr. (Knolls Atomic Power Lab., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 10: 229-30(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38320 MEASUREMENT OF ^{235}U ALPHA IN AN INTERMEDIATE-ENERGY NEUTRON SPECTRUM. Fox, W. N.; Kinchin, G. H.; Sanders, J. E. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). Trans. Amer. Nucl. Soc., 10: 231(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38321 PROTON DECAY FROM ISOBARIC ANALOG STATES FORMED IN THE (d,n) REACTIONS. Cue, N.; Richard, P.; Blair, J. S. (Univ. of Washington, Seattle). Contract AT(45-1)-1388. Phys. Rev. Lett., 19: 450-3(Aug. 21, 1967). (RLO-1388-26).

A study of the cross sections of proton decay of isobaric analog states formed in the (d,n) reaction was made with a variety of medium mass targets. Particular attention is paid to the large variation in cross sections for reactions which proceed through the analogs of $d_{\frac{3}{2}}$, $s_{\frac{1}{2}}$, and $d_{\frac{5}{2}}$ states in the Zr, Mo, and Sn isotopes. At energies ($E_{inc} \sim 16$ MeV) far above threshold this variation is shown to be consistent with a sequential process in which the (d,n) formation mechanism is direct. The cross sections to the target ground states are large only when the neutron decay channels are closed. (auth)

38322 SINGLE-PARTICLE PROTON STATES IN ^{209}Bi EXCITED IN THE (^{3}He,d) REACTION. Woods, R.; Barnes, P. D.; Flynn, E. R.; Igo, G. J. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett., 19: 453-5(Aug. 21, 1967).

A search was made for single-proton levels outside the doubly magic nucleus ^{208}Pb using the reaction $^{208}Pb(^3He,d)^{209}Bi$ at 24 MeV. The deuteron spectrum was recorded, and the excitation energies of the experimentally observed states were compared with theoretical predictions for a proton bound in a static potential well. (D.C.W.)

38323 NUCLEAR RESONANCE FLUORESCENCE AND RAYLEIGH SCATTERING FROM ^{203}Tl. Palathingal, J. C.; Wiedenbeck, M. L. (Univ. of Michigan, Ann Arbor). Nucl. Phys., A101: 193-201(1967). (COO-1112-84).

The lifetime of the 279-keV excited state of ^{203}Tl was determined to be 0.28 ± 0.04 nsec by the method of nuclear resonance fluorescence, using the 212-keV beta radiation for compensation of the recoil energy loss. Using gaseous and liquid sources and a thallium scatterer, the cross sections for resonance fluorescence and Rayleigh scattering processes were determined. The agreement between theory and experiment on Rayleigh scattering cross section obtained from the present measurement lends support to this value of lifetime. (auth)

38324 MEASUREMENT OF INDEPENDENT IODINE FISSION YIELDS IN THE THERMAL FISSION OF ^{235}U. Wunderlich, Frank (Technische Hochschule, Munich). Radiochim. Acta, 7: 105-14(June 1967). (In German).

The fission products emitted by a thermal-neutron-irradiated ^{235}U foil are stopped in flowing nitrogen (atmospheric pressure, room temperature). A few seconds later, the nitrogen–fission product mixture passes nitric acid-treated graphite, where halogens are collected preferentially. The probability of collecting iodine is greater by a factor of about 100 than the probability of collecting tellurium. Presumably this is caused by the fact that the halogens are the only fission products which form volatile compounds in the gas and that these halogen compounds reach the graphite with greater probability than all the other fission products which form aerosols. The fission products collected on the graphite were analyzed by their gamma spectra. Fractional independent yields that were determined for the thermal neutron fission of ^{235}U are: ^{136}I: 0.20 ± 0.08; ^{135}I: 0.56 ± 0.09; ^{133}I: 0.023 ± 0.007; ^{132}I: <0.007. The well-known fractional independent yield of ^{134}I, 0.12, was taken as reference. The yield curve of the iodine isotopes shows a fine structure in the closed shell region N = 82. Fractional cumulative yields that were determined are: ^{136}Te: 0.28 ± 0.08; ^{135}Te: 0.41 ± 0.12. The half life of ^{136}Te was determined as $T_{\frac{1}{2}} \approx 33$ sec. (auth)

38325 THE DECAY OF ^{105}Tc. Kauranen, P.; Karras, M.; Raunemaa, T. (Univ. of Helsinki). Radiochim. Acta, 7: 114-15(June 1967).

Technetium fission products from 14-MeV fission of uranium were rapidly separated using solvent extraction. The decay of ^{105}Tc was investigated by means of a Ge(Li) semiconductor γ spectrometer. ^{105}Tc was found to emit a number of γ rays, the energy and intensity of which are reported. (auth)

38326 THE DECAY OF ^{133}Ba AND NUCLEAR TRANSITIONS IN ^{133}Cs. Blasi, P.; Bocciolini, M.; Maurenzig, P. R.; Sona, P.; Taccetti, N. (Univ., Florence). Nuovo Cim. (10), 50B: 298-308(Aug. 11, 1967).

The relative gamma intensities in the decay of ^{133}Ba are determined by means of lithium-drifted germanium detectors. A reasonable value of the log ft of an EC second-forbidden transition is obtained. The experimental electromagnetic transition strengths connecting 3 excited states and the ground state of ^{133}Cs are found to agree fairly well with the theoretical estimates of the Kisslinger–Sorensen model. (auth)

38327 GAMMA RAYS FROM ^{111}Sn AND ^{116}In. Da Costa, N. L. (Instituto di Fisica, Rio de Janeiro); De Barros Leite, C. V.; De Pinho, A. G.; Goldman, D.; Miyao, Y.; Nascimento, I. C. Nuovo Cim. (10), 50B: 345-54(Aug. 11, 1967).

The gamma spectra of ^{116}In and ^{111}Sn were investigated using a Ge(Li) detector in an attempt to measure the energies more precisely and to observe some possible weak transitions. The half life of ^{111}Sn was measured to be 35.5 ± 0.8 min, and gamma intensities were determined for both decays. Log ft values for the beta branches in the decay of ^{116}In decay were calculated from the appropriate intensities. (D.C.W.)

38328 THE HALF-LIVES OF ^{129}Cs AND ^{130}Cs. Watson, I. A.; Silvester, D. J. (Hammersmith Hospital, London). Radiochim. Acta, 7: 103-4(June 1967).

The half lives of cesium-129 and -130 were redetermined. Experimental details are given; the half lives are calculated to be 32.35 ± 0.10 hr for ^{129}Cs and 29.11 ± 0.12 min for ^{130}Cs. (auth)

38329 THE SPONTANEOUS FISSION OF ^{238}U. Ishimori, T.; Ueno, K.; Kimura, K.; Akatsu, E.; Kobayashi, Y.; Akatsu, J.; Ono, R.; Hoshi, M. (Japan Atomic Energy Research Inst., Tokyo). Radiochim. Acta, 7: 95-103(June 1967).

A study of spontaneous fission, particularly mass distributions and half lives, was carried out during the trial runs of an experimental reprocessing plant of the JAERI. Yttrium, cerium, and silver nuclides were separated from the solution of the fission-product fraction, which comes out of the first pulsed column. The resultant data were used for calculating the half life, together with the data already reported by other authors. The half life for the spontaneous fission of ^{238}U was thus estimated to be $7.191 \pm 0.036 \times 10^{15}$ years. The gamma-ray spectrum of the separated ^{143}Ce, the decay curves of ^{143}Ce, ^{141}Ce, ^{93}Y, ^{91}Y, and ^{90}Y, and mass-distribution curve are shown. (auth)

38330 ANOMALIES OF ACTINIUM. Haissinsky, M. (Paris Univ.). Radiochim. Acta, 7: 61-3(June 1967). (In French).

It was shown many years ago that in some chemical separations of lanthanides containing Ac, the latter is found in the fraction corresponding to Pm, instead of immediately following, or preceding La. In addition, the measurements of the half life of ^{227}Ac freshly extracted from its minerals gave anomalously low values. The nuclear anomaly may be explained by supposing that an isotope of Nd or Eu, presumed to be stable, is in fact radioactive with a very long half life and produces by α or β transformation a Pm isotope with an appropriate half life; for example $^{151}Eu \xrightarrow{\alpha} {}^{147}Pm$. New experiments are necessary to test this hypothesis and to see if it can explain the chemical anomalies as well. (auth)

38331 INELASTIC PROTON SCATTERING FROM ^{90}Zr AND ^{92}Zr. Matsuda, Kazuhisa; Nakamura, Hitoshi; Nonaka, Itaru; Taketani, Hiroshi; Wada, Takeshi; Awaya, Yohko; Koike, Masahiro (Tokyo Univ.). J. Phys. Soc. Jap., 22: 1311-20(June 1967).

Differential cross sections of the inelastic proton scattering for low-lying states of ^{90}Zr and ^{92}Zr were measured. The incident proton energy was about 14.5 MeV. Inelastic groups were analyzed with a precision magnetic analyzer. Attempts at DWBA fits were made. The general trend of the experimental results is in agreement with that of the work of the Colorado-ORNL group. (auth)

38332 ANALYSES OF 49.6-MeV PROTON SCATTERING FROM THE GROUND AND FIRST EXCITED STATES OF ^{64}Zn AND ^{114}Cd. Edwards, V. R. W. (Nuclear Physics Lab., Oxford). Nucl. Phys., A101: 17-50(1967).

Recent measurements of 50-MeV proton scattering from the ground and first excited states of ^{64}Zn and ^{114}Cd are analyzed using the optical model, the strong coupling approximation (SCA), and the distorted-wave Born approximation (DWBA). The results are used to throw light on optical-model parameter systematics in the energy range 30 to 78 MeV, to estimate the basic accuracy of optical-model cross-section predictions, and to assess the relative merits of the SCA and DWBA methods of analyzing inelastic scattering. (auth)

38333 LIFETIME MEASUREMENTS OF SOME ROTATIONAL LEVELS BY A NEW RECOIL METHOD. II. Ashery, D.; Bahcall, N.; Goldring, G.; Sprinzak, A.; Wolfson, Y. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys., A101: 51-64(1967).

Lifetime measurements of some rotational levels were carried out by observing the decay of the excited nuclei along the recoil path following Coulomb excitation with back-scattered oxygen ions. Mean lives were determined for levels in ^{161}Dy, ^{171}Yb, ^{167}Er, ^{183}W, and ^{190}Os. In ^{161}Dy, the parameter g_R determined from the mean life $g_R = 0.14 \pm 0.02$, is somewhat larger than the value calculated in a pair correlation theory. The abrupt change predicted by this theory in the g_R values from ^{161}Dy to ^{163}Dy is definitely established. (auth)

38334 THE DEUTERON-NUCLEUS EFFECTIVE INTERACTION AND DWBA CALCULATIONS FOR THE ^{90}Zr(d,p)^{91}Zr REACTION. Forster, J. S. (Univ. of Liverpool); Green, L. L.; Henderson, N. W.; Hutton, J. L.; Jones, G. D.; Sharpey-Schafer, J. F.; Craig, A. G.; Stephens, G. A. Nucl. Phys., A101: 113-28(1967).

Angular distributions to the ground and first three excited states of ^{91}Zr were measured in the ^{90}Zr(d,p)^{91}Zr reaction at deuteron energies of 10.00 and 12.00 MeV. Measurements were made at 2.5° intervals from 2.5 to 70° and at 5° intervals from 70 to 160°. Zero-range DWBA calculations gave good fits to the data only if a deuteron potential with real well depth U ≈ 90 MeV was used. Cut-offs in the DWBA could not be made to give acceptable fits. A j-dependence of the $2d_{\frac{5}{2}}$ and $2d_{\frac{3}{2}}$ angular distributions proposed previously by Schiffer et al. was found to be more easily explained as a simple Q-dependence. The main effect on the DWBA fits of including spin-orbit terms in all channels was due to the change required in the non-spin-orbit deuteron parameters to maintain the fit to the deuteron elastic scattering data when vector, spin-orbit terms were included in the deuteron potential. The j-effect predicted by the DWBA was opposite to that originally proposed from experiment. The inclusion of finite range and nonlocal corrections to the DWBA reduced the quality of the fit obtained to the experimental data but did not affect the selection of the potential with U ≈ 90 MeV. (auth)

38335 POLONIUM-193 TO 200 ISOTOPES PRODUCED THROUGH HEAVY ION BOMBARDMENTS. Siivola, Antti (Univ. of Helsinki. Univ. of California, Berkeley). Nucl. Phys., A101: 129-37(1967).

Light polonium isotopes were studied by bombarding enriched ^{185,187}Re targets with ^{19}F ions and ^{194}Pt with ^{12}C ions. The activities were observed by using a fast recoil collection apparatus, and they were identified by cross bombardments and excitation functions. New results were obtained; they are in disagreement with old data. Isomeric pairs were found in odd-mass isotopes. The decay characteristics of the light polonium isotopes were determined. (auth)

38336 NUCLEAR RESONANT SCATTERING OF GAMMA RAYS ON Cu, Sn, AND Bi. Giannini, M.; Oliva, P.; Prosperi, D.; Toumbev, G. (CNEN, Rome). Nucl. Phys., A101: 145-62(1967).

Nuclear resonant scattering experiments were carried out employing γ lines from thermal neutron radiative capture. The cross sections for nuclear resonant scattering and absorption were measured at different temperatures. Angular distributions of the resonance scattered γ rays have been analyzed. The level for the ground-state transitions and the total width were derived for each resonance. (auth)

38337 ELECTRON CAPTURE RATIOS IN THE DECAY OF ^{83}Rb, ^{84}Rb, ^{131}Cs, AND ^{185}Os. Schulz, G. (Univ., Heidelberg). Nucl. Phys., A101: 177-86(1967).

P_L/P_K electron-capture ratios were measured in the decay of ^{83}Rb, ^{84}Rb, ^{131}Cs, and ^{185}Os. Furthermore, a P_M/P_L electron-capture ratio in the decay of ^{185}Os was determined. Using these capture ratios, the disintegration energies of ^{83}Rb and ^{185}Os as well as the exchange corrections for the P_L/P_K capture ratios of Rb, Cs, Os and for the P_M/P_L capture ratio of Os could be evaluated. Besides, it was shown that a transition from the 878-keV to the 873-keV level of ^{185}Re exists. All measurements were done with scintillation crystals containing the respective radioactive nucleus as a constituent of the crystal lattice. (auth)

38338 ELASTIC SCATTERING OF 225-MeV ELECTRONS ON THE ^{139}La NUCLEUS. Shevchenko, N. G.; Afanasyev, N. G.; Savitskii, G. A.; Khvastunov, V. M.; Gulkarov, I. S.; Omelayenko, A. S.; Kovalyov, V. D. (Inst. of Physics and Tech., Kharkov). Nucl. Phys., A101: 187-92(1967).

The absolute differential cross section for elastic scattering on ^{139}La in the angular range 20 to 110° was measured. The differential cross section was theoretically calculated under the assumption that charge distribution in the nucleus ^{139}La is well described by the two-parameter Fermi model. The calculation was within the framework of the high-energy approximation. From the fit of the theoretical curve to the experimental data, the Fermi-model parameter values were determined to be c = 5.71 fm and t = 2.35 fm. (auth)

38339 K = 0$^+$ EXCITED LEVELS IN DEFORMED NUCLEI AND THEIR ROTATIONAL COUPLING. Mikoshiba, Osamu (Tokyo Univ. of Education); Sheline, Raymond K.; Udagawa, Takeshi; Yoshida, Shiro. Contract AT(40-1)-2434. Nucl. Phys., A101: 202-28(1967).

Characteristic features of the excitation spectra of K = 0$^+$ intrinsic states are discussed for even deformed nuclei in the rare-earth region within the framework of the random-phase approximation, using the pairing-plus-quadrupole force model. The distributions in collectiveness of both pairing and quadrupole β vibrations of the ten lowest K = 0$^+$ states are numerically analyzed. The β-vibrational character is more dominant in the spectra of nuclei in the beginning of the deformed region, whereas the pairing modes are relatively more important in the middle of the deformed region. An interaction Hamiltonian that describes the nonadiabatic coupling between the K = 0$^+$ intrinsic excitation and the rotation is derived, using the cranking model. The effects rotational disturbances on both pairing and quadrupole fields are taken into account simultaneously. Then, the Hamiltonian is used to investigate band mixings between the ground and the K = 0$^+$ excited rotational states. Detailed numerical analyses are performed on the deviations of the rotational energies of the ground band from the I(I + 1) law. The relative contributions of various excited states to these deviations are investigated. (auth)

38340 ON THE SPIN VALUE OF THE 14-MSEC SPONTANEOUSLY FISSIONING ISOMER OF ^{242}Am. Vilcov, N. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 487-96(1967).

Several isomeric ratio values for the 14-msec spontaneously fissioning isomer of ^{242m}Am are known. In the present work, by comparing the experimental isomeric ratio values for the ^{242}Pu (d,2n) ^{242m}Am and ^{242}Pu (p,n) ^{242m}Am reactions with the Vandenbosch-Huizenga formalism, the spin value of the ^{242m}Am isomeric state is deduced. The spin value thus obtained is $I_{is} \leq 12$. (auth)

38341 NUCLEAR RESONANCE FLUORESCENCE IN ^{94}Mo, ^{95}Mo, AND ^{96}Mo. Langhoff, H.; Cesareo, R.; Flammersfeld, A. (Univ. Goettingen, Ger.). Z. Phys., 205: 1-7(1967). (In German).

Coulomb fragmentation of Tc_2O_7 molecules initiated by the electron capture in ^{94}Tc, ^{95}Tc, and ^{96}Tc provided a means to broaden the γ emission lines of the Tc isotopes sufficiently that nuclear resonance scattering from ^{94}Mo, ^{95}Mo, and ^{96}Mo became observable. The mean lifetime of the 766-keV level in ^{95}Mo was determined to be τ = 2.9 psec. The angular distribution of the resonantly scattered radiation is only compatible with spin ½ for the 766-keV level and yields an amplitude ratio δ for the mixed M1−E2 transition of $-0.35 < \delta < -0.10$. (auth)

38342 STATIC QUADRUPOLE MOMENT OF THE 2$^+$ STATE IN ^{114}Cd DETERMINED BY COULOMB EXCITATION. Schilling, G. (Case-Western Reserve Univ., Cleveland); Scharenberg, R. P.; Tippie, J. W. Contract AT(11-1)-1420. Phys. Rev. Lett., 19: 318-21(Aug. 7, 1967).

The reorientation effect and quadrupole moment of the 0.558-MeV 2$^+$ state in ^{114}Cd were measured by observing the angular distribution of 25-MeV oxygen ions inelastically scattered off ^{114}Cd nuclei. The scattered ions were detected in coincidence with the de-excitation γ radiation over an angular range from 50 to 160° in the laboratory system. The shape of the angular distribution obtained gives conclusive evidence for the presence of the reorientation effect. (S.F.L.)

38343 SPIN-PARITY ASSIGNMENTS VIA NEUTRON DECAY OF ANALOG RESONANCE. Kim, H. J.; Robinson, R. L.; Kernell, R. L.; Johnson, C. H. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev. Lett., 19: 325-7(Aug. 7, 1967). (ORNL-P-2971).

Since an analog state is isospin forbidden to decay by neutron emission, an experimentally observed "analog resonance" in the (p,n) reaction is due to mixing of the resonant state with densely populated nearby compound states of the same spin and parity J$^\pi$.

That many compound states are involved in the mixing and that they do have the same J^{π}'s implies that the degree of enhancement in the cross section of a (p,n) transition to a particular state of the residual nucleus depends on the spin and parity of that state in a simple way. Thus, a measurement of this enhancement is a useful spectroscopic tool. If the spin and parity of the analog state is 0^+ (an analog of the ground state of an even–even nucleus), the situation is particularly simple. Then the spin and parity I^{π} of a residual state is uniquely given by the single values of the allowed orbital and total angular momenta [$I = j$, $\pi = (-1)^l$] of the neutrons due to the decay of the analog resonance. This technique is demonstrated by the study of the low-lying levels in ^{119}Sb via the reaction ^{119}Sn(p,n)^{119}Sb. A sharp anomaly occurs in the cross section at the incident energy where the $J^{\pi} = 0^+$ analog to the ground state in ^{120}Sn is expected. Neutron spectra obtained at 90° for the reaction at proton energies of 4.642 MeV (on resonance) and 4.709 MeV (off resonance) are given. The peaks are identified with the reaction ^{119}Sn(p,n)^{119}Sb feeding known states of ^{119}Sb. The observed enhancement of the (p,n) cross section in the vicinity of the analog state is discussed. (S.F.L.)

38344 ANALOGUE STATES OF THE DEFORMED ^{173}Yb AND ^{175}Yb NUCLEI. Adam, A.; Cassagnou, Y.; Foissel, P.; Gastebois, J.; Levi, C.; Papineau, L. (CEN, Saclay, France). Phys. Lett., 25B: 122-3(Aug. 7, 1967).

Analog states of ^{173}Yb and ^{175}Yb are studied through elastic and inelastic proton scattering. Relative intensities of the resonances give a test for Nilsson's coefficients. (auth)

38345 NUCLEON WIDTHS OF ISOBARIC ANALOGUE STATES IN NUCLEI. II. Balashov, V. V.; Yadrovskii, E. L. (Moscow State Univ.). Phys. Lett., 25B: 67-71(Aug. 7, 1967).

Calculations in ^{90}Zr and a description of the analogue state in ^{208}Bi are given. (auth)

38346 PARITY NON-CONSERVATION IN THE GAMMA DECAY OF ^{181}Ta. Lobashov, V. M.; Nazarenko, V. A.; Saenko, L. F.; Smotritskii, L. M.; Kharkevitch, G. I. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett., 25B: 104-6(Aug. 7, 1967).

A method of integral detection of γ quanta with subsequent resonance separation and storage of a periodic signal was used to measure the circular polarization of γ quanta in ^{181}Ta (a transition of 482 keV). The value of the polarization obtained is $P_\gamma = -6 \pm 1 \times 10^{-6}$. This result agrees with the data obtained by the authors earlier, $P_\gamma < 2 \times 10^{-5}$, and is at variance with the value reported by Boehm and Kankeleit, $P_\gamma = -2 \pm 0.4 \times 10^{-4}$. The amplitude of the nucleon-nucleon weak interaction estimated from a comparison with experimental data on ^{175}Lu is $F \approx 2 \pm 4 \times 10^{-7}$. (auth)

38347 THE MOESSBAUER EFFECT IN ^{191}Ir AND ^{189}Os. Jha, S.; Owens, W. R.; Gregory, M. C.; Robinson, B. L. (Case Inst. of Tech., Cleveland. Western Reserve Univ., Cleveland). Phys. Lett., 25B: 115-17(Aug. 7, 1967).

The Mössbauer effect was observed in ^{191}Ir following the decay of ^{191}Pt ($T_{\frac{1}{2}} = 3.0$ d, $E_\gamma = 82.4$ keV) and in ^{189}Os following the decay of ^{189}Ir ($T_{\frac{1}{2}} = 13.3$ d, $E_\gamma = 69.6$ keV). (auth)

38348 ENERGY DEPENDENCE OF HIGH-ENERGY K-CONVERSION COEFFICIENTS. Smither, R. K. (Argonne National Lab., Ill.). Phys. Lett., 25B: 128-9(Aug. 7, 1967).

The K-conversion coefficients for the 1 to 9-MeV region of the ^{113}Cd(n,γ)^{114}Cd γ-ray spectrum are obtained by combining the Ge-diode analysis of the (n,γ) spectrum with the conversion-electron intensities from the previously published work of von Egidy and Kaiser. The K-conversion coefficient was found to depend on the γ-ray energy as $E_\gamma^{-1.96}$ for the E1 radiation and as $E_\gamma^{-2.18}$ for the M1 radiation. Contrary to the suggestion from extrapolating the theoretical calculation, the values of the E1 and M1 conversion coefficients do not cross at high energies. At 9 MeV they still differ in the ratio of 1.7:1.0. (auth)

38349 THE ^{91}Zr(^{3}He,d) REACTION TO THE POSITIVE AND NEGATIVE PARITY LOW-LYING STATES IN ^{92}Nb. Ball, J. B.; Cates, M. R. (Oak Ridge National Lab., Tenn.). Phys. Lett., 25B: 126-8(Aug. 7, 1967).

The reaction ^{91}Zr(^{3}He,d)^{92}Nb was studied to reinvestigate the level scheme of ^{92}Nb. In addition to confirming spin assignments for the positive-parity levels previously observed in the ^{93}Nb(p,d) and (d,t) reactions, the negative-parity levels are also defined. (auth)

38350 OBSERVATION OF THE NUCLEAR RAMAN SCATTERING BY ^{181}Ta. Shimizu, S.; Isozumi, Y.; Nakayama, Y. (Kyoto Univ.). Phys. Lett., 25B: 124-5(Aug. 7, 1967).

One of the nuclear Raman scattering lines from ^{181}Ta using γ rays was observed. A possible explanation is proposed for a considerable deviation of the result from the theoretical value. (auth)

38351 DIRECTIONAL CORRELATIONS OF GAMMA RAYS IN THE DECAY OF ^{187}W. Gupta, S. L.; Bajaj, M. M.; Saha, N. K. (Univ. of Delhi). Proc. Nat. Inst., Sci. India, Pt. A, 32: 281-91(May 1966).

Gamma-gamma directional correlations are measured for the cascades 72–134 keV and 552–134 keV in ^{187}Re following the beta decay of 24-hr ^{187}W. The results favor a spin of $\frac{9}{2}$ for the 206-keV level and $\frac{5}{2}$ for the 686-keV level and support the recent findings from the (d,d') and (α,α') inelastic scattering experiments in ^{187}Re. From the measured E2/M1 mixing ratio of the 134-keV transition, transition probabilities of the M1 and the E2 components are estimated and are compared with the Weisskopf and the Nilsson estimates. (auth)

38352 THEORY OF INELASTIC NEUTRON SCATTERING IN NEARLY FERROMAGNETIC METALS. Doniach, S. (Imperial Coll. of Science and Tech., London). Proc. Phys. Soc. (London), 91: 86-96(May 1967).

Paramagnetic neutron scattering at zero temperature in a one-band itinerant electron model of a metal is discussed in terms of the random-phase approximation formula of Izuyama, Kim and Kubo [J. Phys. Soc. Japan, 18: 1025(1963)] for the q, ω dependent generalized susceptibility of an electron gas. The formula is evaluated numerically in the effective mass approximation, and qualitative comparison made with simple sum rules for a localized spin paramagnet. The formula is also applied to predict neutron scattering cross sections at fixed scattering angle. The itinerant character produces a reduction in the scattering intensity additional to that produced by the atomic form factor. The use of neutron scattering in the determination of the unrenormalized band mass of the d-band holes in palladium is discussed. Comparison is made with experiments of Cable and Wollan [Phys. Rev., 140: A2003-4(1965)] for scattering on palladium. It is suggested that the paramagnetic scattering should be observable at sufficiently small angles. (auth) (UK)

38353 SYNTHESIS OF Fm ISOTOPES WITH MASS NUMBERS 247 AND 246. Flerov, G. N.; Polikanov, S. M.; Mikheev, V. L.; Ilyushchenko, V. I.; Miller, M. B.; Shchegolev, V. A. At. Energ. (USSR), 22: 342-6(May 1967). (In Russian).

The isotopes ^{247}Fm, ^{247m}Fm, and ^{246}Fm were synthesized at the 310-cm heavy ion cyclotron at JINR by irradiation of ^{239}Pu with ^{12}C. The recoil atoms were collected by means of gaseous jets with subsequent recording of the α decay by means of Si(Au) detectors. For the isotope ^{247}Fm α activities with two different half lives were obtained, one after the other, with complex groups of α particles: $E_\alpha = 7.87 \pm 0.05$ Mev (~70%) and $E_\alpha = 7.93 \pm 0.05$ Mev (~30%), the half life of which is $T_{\frac{1}{2}} = 35 \pm 4$ sec; the other with $E_\alpha = 8.18 \pm 0.03$ MeV and $T_{\frac{1}{2}} = 9.2 \pm 2.3$ sec. The data on the nature of the isotope ^{246}Fm ($E_\alpha = 8.25 \pm 0.03$ MeV and $T_{\frac{1}{2}} = 1.6 \pm 0.4$ sec), synthesized at JINR in 1966, were confirmed. (tr-auth)

38354 POSITRON EMISSION FROM ^{105}Ag AND RELATED ASPECTS OF ^{105}Ag DECAY. Pierson, William R.; Rengan, K. (Ford Motor Co., Dearborn, Mich.). Phys. Rev., 159: 939-51(July 20, 1967).

Positron emission in the decay of 40-day ^{105}Ag was discovered by detection of the 180°-coincident annihilation γ rays. The intensity is 8.6 ± 1.4 positrons per million ^{105}Ag disintegrations. Of these, only about 2 ± 2% can be attributed to processes associated with γ transitions, leaving 8.5 ± 1.5 positrons per million disintegrations attributable only to positron emission as a mode of β decay of ^{105}Ag. By $\gamma\gamma\gamma$ triple-coincidence measurements, it was found that these positrons (or the bulk of them) are not in coincidence with γ rays, and hence that the transition is probably between the ^{105}Ag and ^{105}Pd ground states. The spectrum of the positrons was obtained by $\beta\gamma\gamma$ triple-coincidence measurements, and it was found to have an endpoint of 325 ± 25 keV. The implied log f_1t value (8.5) is within the range predicted for the expected but hitherto-undocumented unique first-forbidden transition between the ^{105}Ag and ^{105}Pd ground states, the spins and parities of both of which are known ($\frac{1}{2}- \rightarrow \frac{5}{2}+$). Radiations observed by means of NaI(Tl), Ge(Li), and Si(Li) spectrometry were the Pd K x rays (abundance 78% of the ^{105}Ag disintegrations) and the following γ rays: 64.07 (11%), ≈155 (≈0.5%), 182.7 (≈0.5%), 280.5 (32%), 306.3 (0.7%), 319.4 (4%), 331.6 (4%), 344.5 (42%), 360.7 (0.6%), 370.2 (0.7%), 392.8 (2%), 415.5 (0.2%), 443.4 (11%), 526.4 (0.09%), 560.4 (0.5%), 617.8 (1%), 644.4 (10%), 649.6 (3%), 673.2 (0.9%), 726.3 (0.2%), 743.1 (0.5%), 807.3 (1%), 961.5 (0.1%), and 1087.8 (4%) keV. By x-γ coincidence measurements, it was shown that the lifetime of the 344-keV level of ^{105}Pd is short ($t_{\frac{1}{2}} < 6 \times 10^{-9}$ sec), in contradication to recent assertions. The ^{105}Ag half-life was measured to be 41.2 ± 0.3 days. (auth)

38355 FAST-NEUTRON SCATTERING FROM NUCLIDES IN THE LEAD REGION. Cranberg, Lawrence (Univ. of Virginia, Charlottesville. Los Alamos Scientific Lab., N. Mex.);

Oliphant, Thomas A.; Levin, Jules; Zafiratos, C. D. Contract W-7405-eng-36. Phys. Rev., 159: 969-79(July 20, 1967). (LA-DC-8439).

Experimental results and calculations are presented of an investigation of elastic and inelastic scattering of neutrons from bismuth and from separated isotopes of lead. Data are presented on spectroscopic properties of resolvable energy levels, excitation functions, nuclear temperatures, and angular distributions, with special emphasis on the application of the Wolfenstein–Hauser–Feshbach theory with width-fluctuation correction. (auth)

38356 INTERNAL-CONVERSION-ELECTRON STUDY OF THE DECAY OF ^{133}Ba TO ^{133}Cs. Hennecke, Hans J. (Aerospace Research Labs., Wright-Patterson AFB, Ohio); Manthuruthil, J. C.; Bergman, O.; Cothern, C. R. Phys. Rev., 159: 955-68(July 20, 1967).

The 40- to 500-keV region of the internal-conversion-electron spectrum from the decay of ^{133}Ba was investigated with an iron-core, $\pi\sqrt{2}$ double-focusing spectrometer. Transitions of 383.79(7), 355.92(6), 302.78(5), 276.35(5), 223.15(5), 160.58(4), 80.990(22), 79.622(18), and 53.152(20) keV were observed, and their multipolarities were determined from measurements of the conversion-electron intensity ratios–$L_1/L_2/L_3$ and/or K/L. No new lines with intensity greater than 2.3% of the 356K line were found. The 437K line was found to have an intensity less than 0.01% of the 356K line. The multipolarities obtained for the nine observed transitions were compared with previous measurements of α_K and γ-γ angular correlations. This comparison resulted in unique spin-parity assignments of $\frac{1}{2}^+$, $\frac{5}{2}^+$, $\frac{5}{2}^+$, $\frac{3}{2}^+$, and $\frac{1}{2}^+$ for the ground state and the 80.997(6)-, 160.58(4)-, 383.79(7)-, and 436.93(6)-keV levels, respectively, in ^{133}Cs. The measurements of K/L_3 and L_1/L_3 for the 161-keV transition are consistent with previous 276-161 γ-γ directional-correlation measurements only if penetration effects are included with a λ value of 45 ± 10 or 180 ± 20, where λ is defined as the ratio of the penetration matrix element to the normal γ-ray matrix element. (auth)

38357 INTEGRATED CROSS SECTIONS FOR ^{209}Bi(γ,xnyp) REACTIONS. Wyckoff, James M. (National Bureau of Standards, Washington, D. C.). Phys. Rev., 159: 953-4(July 20, 1967).

Integrated cross sections for the photoproduction of $^{200-206}$Bi and $^{200-204}$Pb from ^{209}Bi were measured. A single sample was activated during a 10-minute 137-MeV bremsstrahlung bombardment, and γ rays from the daughter products were measured with a Ge(Li) spectrometer over a two-month period to obtain relative yields. The yield data were used along with the established (γ,2n) integrated cross section and a calculated thick-target bremsstrahlung spectrum to derive integrated cross sections as follows: ^{206}Bi (168 ± 25), ^{205}Bi (88 ± 22), ^{204}Bi (55 ± 16), ^{203}Bi (66 ± 23), ^{202}Bi (31 ± 12), ^{201}Bi (10.7 ± 5.9), ^{200}Bi (5.7 ± 3.4), ^{204}Pb (8.0 ± 2.4), ^{203}Pb (3.8 ± 1.3), ^{202}Pb (3.4 ± 1.3), ^{201}Pb (15.3 ± 8.4), and ^{200}Pb ($1.62 \pm .97$) MeV mb. Evidence is also presented for an 11.5-h isomeric state in ^{200}Pb. (auth)

38358 DISINTEGRATION OF ^{113}Sn. Bosch, H. E.; Simon, M. C.; Szichman, E.; Gatto, L.; Abecasis, S. M. (DINFIA, Buenos Aires). Phys. Rev., 159: 1029-32(July 20, 1967).

A reinvestigation of the decay of 119-day ^{113}Sn was carried out with scintillation spectrometers, as well as with lithium-drifted silicon and germanium detectors. In addition to x rays, two γ rays of 0.2555 ± 0.0005 and 0.3910 ± 0.0005 MeV were found of relative intensity $(2.9 \pm 0.3) \times 10^{-2}$. The K-conversion coefficient of the 0.2555-MeV transition was measured to be 0.040 ± 0.006 and that of the 0.3910-MeV transition, 0.49 ± 0.04 [$K/(L + M) = 4.2 \pm 0.4$]. The electron-capture ratio $P_{EC}(L + M + \ldots)/P_{EC}(K)$ to the 0.6465-MeV level of ^{113}In was determined to be 0.33 ± 0.14. The bremsstrahlung endpoint energy to the same level was 0.080 ± 0.005 MeV. From these values, the decay energy transitions to that level were deduced to be $0.050 - 0.110$ MeV and 0.110 ± 0.005 MeV, respectively. A decay scheme is constructed. (auth)

38359 RESONANCE FLUORESCENCE IN ^{187}Re. Langhoff, H. (Franklin Inst., Swarthmore, Pa.). Phys. Rev., 159: 1033-8(July 20, 1967).

The excited levels of ^{187}Re which are populated in the decay of ^{187}W were investigated by the resonance-fluorescence method. Applying the centrifuge technique and Li-drifted germanium counter as detector for the scattered radiation, resonance fluorescence from the levels at 880, 864, 773, 686, 618, and 512 keV was identified. With the most likely spin values for these levels, the following mean lifetimes were obtained: 880-keV level, 0.44 ± 0.13 psec; 864-keV level, 2.7 ± 0.9 psec; 773-keV level, 0.25 ± 0.02 psec; 686-keV level, 8.6 ± 0.5 psec; 618-keV level, 15.7 ± 1.3 psec; and 512-keV level, 23 ± 8 psec. No scattering was observed from the levels at 589 and 625 keV. The investigation of the γ spectrum emitted by the ^{187}W source with a Li-drifted germanium detector revealed a new transition at 816.3 ± 0.5 keV. The results are discussed on the basis of the Nilsson model. (auth)

38360 ^{208}Pb(d,p) AND (d,t) REACTIONS WITH 15- TO 25-MeV DEUTERONS. Muehlehner, G. (Univ. of Michigan, Ann Arbor); Poltorak, A. S.; Parkinson, W. C.; Bassel, R. H. Phys. Rev., 159: 1039-49(July 20, 1967). (COO-1112-82; BNL-11086).

The differential cross sections for the single-particle states of ^{209}Pb and single-hole states of ^{207}Pb excited in the ^{208}Pb(d,p) and ^{208}Pb(d,t) reactions, respectively, were measured using deuterons of energies 14.8, 20.1, and 24.8 MeV and the distorted-wave-approximation parameters for fitting the data determined. As a result, it is now possible to determine l values with confidence and to extract spectroscopic factors with a reliability of about 30% from data for high-A nuclei in this range of deuteron energies. (auth)

38361 TOTAL NEUTRON CROSS SECTION OF LANTHANUM. Shwe, Hla; Cote, R. E.; Prestwich, W. V. (Argonne National Lab., Ill.). Phys. Rev., 159: 1050-6(July 20, 1967).

The total neutron cross section of lanthanum was measured from 0.1 to 1000 eV with the Argonne fast chopper. In order to explain its variation over the entire range, it is necessary to assume contributions by bound states together with contributions by the measured resonances at positive energies. The data could be fitted by assuming a bound level whose resonance parameters are the resonance energy $E_0 = -37.5$ eV, the reduced neutron width $\Gamma_n^0 = 0.115$ eV, and the radiation width $\Gamma_\gamma = 0.0565$ eV. The parameters for the resonances at 0.734, 2.994, 20.5, 72.3, 618, and 1182 eV were measured. The state of ^{139}La + neutron at the neutron energy of 72.3 eV was identified to be $J^\pi = 3^+$ on the basis of the observed γ-ray spectrum. The potential-scattering radius is measured to be 5.2 ± 1.0 F. Resonances at energies up to about 11 keV were detected. On the basis of the measured positive-energy resonances and the negative-energy bound level, the thermal capture cross section was calculated to be 9.6 ± 0.7 b. The resonance-capture integral is 12.1 ± 1.0 b. The s-wave neutron strength function S_0 for ^{139}La is 0.7×10^{-4}. (auth)

38362 BETA–GAMMA CORRELATION MEASUREMENTS ON ^{192}Ir. Bhattacherjee, S. K.; Mitra, S. K.; Jain, H. C.; Padhi, H. C. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 159: 1056-62(July 20, 1967).

The β-γ directional correlation between β particles in the 536-keV group and the 605- and 612-keV γ rays in the decay of 72-day ^{192}Ir was measured at several β-ray energies. The measured correlation coefficient $\epsilon(W)$ rises from -0.074 ± 0.015 at 185 keV to -0.096 ± 0.010 at 255 keV and then starts falling; near the endpoint energy the anisotropy is found to be very small. The large β-γ anisotropy observed conclusively establishes that the parity of ^{192}Ir is negative. Attempts were made to extract information about the relevant matrix-element ratios governing the 536-keV β transition. The β-γ directional correlation between β particles in the outer group of 669-keV and the 469-keV γ ray was also measured; it shows nearly isotropic correlation in the β energy region 400–650 keV. The β-γ circular-polarization correlation in the above cascade was also measured. It is concluded that while large cancellation among the vector-type matrix elements is responsible for the observed energy dependence of the β-γ anisotropy in the 536-keV β group, the outer β group of 669 keV apparently satisfies the quasi-allowed approximation. The nature of the 785-keV (4^+) and 921-keV (3^+) states in ^{192}Pt is discussed in the light of these findings. (auth)

38363 NEUTRON PRODUCTION IN Ag, Ta, Au, Pt, AND Pb BY THE INTERACTION OF 7.5- TO 4-MeV PROTONS. Thomas, Richard G. Jr.; Bartolini, W. (Univ. of California, Livermore). Contract W-7405-eng-48. Phys. Rev., 159: 1022-8(July 20, 1967). (UCRL-14976).

Use was made of a large liquid scintillator to determine excitation functions for (p,n) + (p,pn) and (p,2n) interactions in Ag, Ta, Au, Pt, and Pb. A value of 1.6 F was deduced for r_β, the nuclear radius parameter. Comparison of these data with the reaction cross sections obtained in another experiment confirms that neutron production is the dominant process for these elements at 10 MeV. The simple statistical model in which only neutron emission is assumed provides a reasonably satisfactory explanation of the observed behavior, but other results indicate that the (p,pn) process could be significant in these elements. (auth)

38364 ALPHA-DECAY PROPERTIES OF NEUTRON-DEFICIENT ISOTOPES OF EMANATION. Valli, Kalevi; Nurmia, Matti J.; Hyde, Earl K. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 159: 1013-21(July 20, 1967). (UCRL-16735(Rev.)).

Isotopes of emanation (element 86) with 126 or fewer neutrons were prepared at the Heavy Ion Linear Accelerator by bombardment of platinum, gold, mercury, and thallium targets with ^{16}O, ^{14}N, and ^{12}C nuclei. Several techniques were developed for isola-

tion of the gaseous products. Si(Au) surface-barrier detectors were used to measure α particles emitted by emanation isotopes and by their polonium and astatine daughters. Mass-number assignments of new isotopes of mass 201 through 205 were based on genetic relations and on excitation functions. The probable nature of the isomerism observed in ^{205}Em is discussed. Properties of isotopes with masses 206 through 212 were confirmed. (auth)

38365 CAPTURE-CROSS-SECTION STUDIES FOR 30- TO 220-keV NEUTRONS USING A NEW TECHNIQUE. Macklin, R. L.; Gibbons, J. H. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev., 159: 1007-12(July 20, 1967). (ORNL-P-2899).

Neutron-radiative-capture cross sections were measured at various energies from 30 to 220 keV using a new "total-energy-detector" technique of high sensitivity, applicable to small samples of separated stable isotopes. Samples studied are: V, Fe, Ni, ^{86}Sr, ^{87}Sr, Y, Nb, Rh, Ag, ^{122}Te, ^{123}Te, ^{124}Te, ^{125}Te, ^{126}Te, ^{128}Te, ^{130}Te, I, Eu, ^{175}Lu, ^{176}Lu, W, Au, ^{204}Pb, and ^{205}Pb. The odd-odd isotope ^{176}Lu shows a substantially higher cross section than those of neighboring odd-even and even-odd nuclei. The results for europium (2 b near 65 keV) emphasize the peak expected from previous studies of systematics. The Sr and Te isotopic results strongly confirm the predictions of s-process stellar nucleosynthesis. (auth)

38366 DECAY PROPERTIES OF NEUTRON-DEFICIENT OSMIUM AND RHENIUM ISOTOPES. II. THE A = 180 DECAY CHAIN. Hofstetter, K. J.; Daly, P. J. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1672. Phys. Rev., 159: 1000-6(July 20, 1967). (COO-1672-1).

The decay properties of ^{180}Os and ^{180}Re were investigated using Ge(Li), anthracene, and NaI(Tl) detectors in singles and coincidence measurements. A solvent extraction method for rapid milking of daughter rhenium activities from osmium was used to confirm the genetic relation between 21.5-min ^{180}Os and 2.45-min ^{180}Re. No radiations other than K x rays were detected in ^{180}Os decay, and it is concluded that this isotope decays by electron capture with a log ft value in the range 4.7 ± 0.3. In ^{180}Re decay the following radiations were identified: K x rays (105), γ rays of energies 103.6 ± 0.3 (26), 232.6 ± 1.0 (1.2), 750.8 ± 1.0 (0.8), 826.4 ± 0.8 (11), and 902.2 ± 0.5 keV (100), and a single positron group of endpoint 1.76 ± 0.4 MeV (8). Relative intensities are given in parentheses. A ^{180}Re decay scheme which is consistent with all the observations, including $\gamma-\gamma$ coincidence measurements, is proposed; its most interesting feature is a two-quasi-particle state ($J^\pi = 2^-$) at 1006 keV, which de-excites almost exclusively to the first excited state of ^{180}W. The disintegration energy of ^{180}Re was determined to be 3.78 ± 0.04 MeV. (auth)

38367 EFFECTS OF PAIRING AND BLOCKING ON THE STRUCTURE OF THE OCTUPOLE SEPTUPLET OF ^{209}Bi. Hafele, J. C. (Washington Univ., St. Louis). Phys. Rev., 159: 996-1000(July 20, 1967).

The Pauli principle and the nuclear pairing interaction are shown to play a major role in the determination of the level structure of the 2.6-MeV octupole multiplet of ^{209}Bi. (auth)

38368 DECAY OF ^{147}Eu TO LEVELS IN ^{147}Sm. Adam, I. (Univ. of Copenhagen); Toth, K. S.; Meyer, R. A. Phys. Rev., 159: 985-95(July 20, 1967). (ORNL-P-2913).

A recent investigation of the conversion-electron spectrum of ^{147}Eu has revealed numerous new transitions in ^{147}Sm. The present study was undertaken to supplement these conversion-electron data with γ-ray information obtained with high-resolution Ge(Li) counters. Singles γ-ray spectra were obtained, and $\beta^+-\gamma$(NaI), e-γ(NaI), and e-γ(Ge(Li)) coincidence measurements were made. A value of 1767 ± 10 keV was determined for the ^{147}Eu decay energy. K-shell internal-conversion coefficients were calculated for most of the observed transitions by intercomparison of the photon intensity data with published conversion-electron intensity data. The existence of previously reported ^{147}Sm excited states at 121.3, 197.4, 798.9, 1054, 1077, 1319, 1454, and 1550 keV was confirmed. The experimental information accumulated in this study also indicates new levels at (1007), 1065, 1180, (1228), 1450, 1472, 1656, and (1664) keV. Levels enclosed in parentheses are only tentatively proposed. A small percentage of direct ^{147}Eu decay to the first three states in ^{147}Sm was found to proceed by positron emission. The following (K-capture/β^+) ratios were measured: 258 ± 100 (ground state), 257 ± 100 (121.3-keV state), and 302 ± 150 (197.4-keV state). (auth)

38369 STUDIES OF THE ALPHA DECAY OF ^{233}U. Trojan, O. A.; McNeill, K. G.; Steenberg, N. R. (Univ. of Toronto). Nucl. Phys., A100: 609-18(1967).

The decay of ^{233}U through the first and second excited states of ^{229}Th was studied using a uranium oxide source. The half life of the first excited state of ^{229}Th was found to be less than 1.9 nsec; it decays by an almost pure M1 transition. The half life of the second excited state of ^{229}Th was found to be 0.5 ± 0.2 nsec; this level de-excites by E2 cross-over radiation in 96% of events. Contrary to expectations, an anisotropic alpha–gamma angular correlation was not found, and the probable reason for this is discussed. (auth)

38370 HIGH-RESOLUTION STUDIES OF THE GAMMA RAYS FROM ISOMERIC STATES WITH HALF-LIVES OF 10 μs TO 30 ms IN NUCLEI WITH Z = 63–83. Conlon, T. W. (Princeton Univ., N. J.). Contract AT(30-1)-937. Nucl. Phys., A100: 545-73(1967). (PUC-937-252).

Eight new isomeric states with half lives in the range 10 μs to 30 ms were identified following bombardment of the natural elements and separated isotopes of the elements Eu to Pb with 17.5-MeV protons. Improved data on 14 previously reported, isomeric states were also obtained. The energies, half lives, and multipolarities of the gamma rays from these states were measured using an 8 cm^3 Ge(Li) detector. In most cases, level schemes were constructed, and the spin and parity of the isomeric level and intermediate levels populated in the decay were determined. A group of hindered E2 transitions were observed, all of which are retarded by approximately the same degree e.g. 3×10^{-3} Weisskopf units. The results are discussed in terms of the Nilsson model and in terms of the selection rules for transitions between Nilsson states. (auth)

38371 FAST NEUTRON PRODUCTION WITH 54 MeV DEUTERONS. Schweimer, G. W. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Phys., A100: 537-44(1967).

The yields of neutrons above 10 MeV produced by irradiating 14 elements with 54-MeV deuterons were determined. Energy spectra in the forward direction were measured with a time-of-flight technique. The angular distributions were measured with threshold detectors. The observed neutron spectra were compared with theoretical results for nuclear and Coulomb break-up of deuterons. (auth)

38372 FIRST EXCITED STATE OF ^{121}Sb. Beard, G. B.; Snyder, R. E. (Wayne State Univ., Detroit). Phys. Lett., 25B: 18-19(July 24, 1967).

The low-energy photon spectra from sources of ^{121}Te^m and ^{121}Sn^m were investigated. No evidence for a previously reported 9 keV γ ray was obtained and it is concluded that the 37 keV level is the first excited state of ^{121}Sb. (auth)

38373 MEASUREMENT OF THE DOPPLER EFFECT FOR ^{238}U CAPTURE AND ^{235}U FISSION IN A FAST NEUTRON SPECTRUM. Pflasterer, George Russell Jr. Stanford, Calif., Stanford Univ., 1966. 190p.

Thesis.

The Doppler effect in ^{238}U capture and ^{235}U fission was measured by means of a foil activation technique in the fast neutron spectrum core of the Mixed Spectrum Critical Assembly. Experimental results were obtained for two ^{238}U foil thicknesses and one ^{235}U foil thickness. The amount of scattering material between the foil and surrounding core fuel was varied to determine the effect on the Doppler measurement of change in the incident flux fine energy structure in the resonances. In this experiment only the foil is heated, while the core fuel remains at room temperature. The measured ^{238}U Doppler effect expressed as the ratio (change in foil activity with temperature/room temperature foil activity), R-1 was a factor of 2 higher than that calculated using a neutron energy spectrum derived from "nominal" material cross sections. Presently available cross sections in the energy range of interest are sufficiently uncertain so that it is possible to infer from them "hard" or "soft" neutron energy spectra such that the value of R-1 varies by a factor of two. The measured values for ^{238}U agreed quantitatively with those found from the "soft" neutron energy spectrum. Within the precision of the measurement no ^{235}U Doppler effect was observed. The calculated ^{235}U Doppler effect was smaller than the sensitivity of the experiment, thus within its precision (±0.002) the measurement confirms the theory. (Disser. Abstr.)

Nuclear Theory

Refer also to abstracts 38166, 38220, 38221, 38232, 38244, 38248, 38252, 38257, 38291, 38332, and 38339.

38374 (AAEC/TM-388) SEMICLASSICAL MODEL OF DIRECT REACTIONS. Robertson, I. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). May 1967. 10p. Dep.

The semiclassical model of direct reactions is reviewed, and

its predictions are presented for a reaction which exhibits the phenomenon of backward peaking, following the work of Pearson. The curve σ (180°) versus energy is fitted quite closely; the shape of the curve has a simple explanation in terms of the bound-state radial wave functions. To check the validity of the model, the corresponding distorted-wave Born approximation (DWBA) calculations are carried out; little agreement is found. The semiclassical model severely overestimates the spatial localization in the exact matrix element, and therefore gives cross sections which have a much faster energy variation than the DWBA cross sections. The DWBA calculation can not explain the experimental results on backward peaking, and it is concluded that the agreement between the semiclassical model and experiment is fortuitous. (auth)

38375 (MIT-2098-351) COEFFICIENTS OF FRACTIONAL PARENTAGE IN j-j COUPLING. Hubbard, Lincoln (Massachusetts Inst. of Tech., Cambridge). Feb. 1967. Contract AT(30-1)-2098. 97p. Dep. CFSTI.

In shell model calculations, the matrix element of an nth-order operator can be reduced to a linear combination of n-particle matrix elements through the application of the Racah algebra and the coefficients of fractional parentage (c.f.p.). For computer calculation, the numerical evaluation of the terms arising from the Racah algebra is carried out relatively easily by formula. However, the c.f.p. for any but the simplest cases are not easily evaluated by a general formula. A computer code is therefore presented to calculate the j-j c.f.p. by a recursion relation. The code is able to calculate either the c.f.p. of identical particles (neutrons or protons alone) or the c.f.p. in the isospin formalism. (S.F.L.)

38376 (NP-16890) ON A COMPUTER METHOD FOR DEDUCING NUCLEAR LEVELS FROM MEASURED TRANSITION ENERGIES. Baecklin, Anders (Uppsala Univ. (Sweden). Inst. of Physics. Forskningradens Laboratorium, Studsvik (Sweden)). 1967. 7p. (LF-17). Dep.

The development of high-resolution beta and gamma spectrometers with good efficiency has made very complex detailed measurements possible. Spectra containing hundreds of lines within an energy interval of the order of 1 MeV are measured from beta decay and from neutron capture reactions. In these spectra, it is difficult to obtain coincidence information except for the strongest transitions. Reliance must therefore be based almost entirely on energy relations for plotting of the level scheme. However, the great number of transitions makes the application of such methods time consuming and difficult to carry out manually. Two computer programs are described, one for finding possible excited levels from a set of transition energies and a set of known energy levels, by the first program based on accidental energy combinations. The input data level finding program title is NUCLEV, and the calculation program title is PNAC. (SWEDEN)

38377 (PUC-937-260) ANNUAL PROGRESS REPORT [ON NUCLEAR PHYSICS] FOR THE PERIOD APRIL 1966-APRIL 1967. Sherr, R. (Princeton Univ., N. J. Palmer Physical Lab.). Contract AT(30-1)-937. 49p. Dep. CFSTI.

INDIUM ISOTOPES—production of atomic beams of, methods development for
ANTIMONY-115, ANTIMONY-117, ANTIMONY-119, ANTIMONY-120—nuclear moments, spin, and hyperfine structure
ANTIMONY-118—nuclear moments, spin, and hyperfine structure of isomeric
SODIUM-20—production of atomic beams of, for magnetic resonance experiments
VANADIUM-46, SCANDIUM ISOTOPES—energy levels of, calculations using shell model
VANADIUM-47, SCANDIUM-48—nuclear spin of, measurement using atomic beam magnetic resonance
ATOMIC BEAMS—production for magnetic resonance experiments, methods development for
SILVER-106—nuclear magnetic moment and hyperfine structure of, measurement using atomic beam magnetic resonance
NUCLEI—energy levels of even-Z N = 53 to 61, low-lying
MAGNETOMETERS—development of flowing-water NMR
TECHNETIUM-95—energy-level transitions from molybdenum-95 (p,n) reactions, with proton emission
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CALCIUM-40, CALCIUM-48—proton elastic scattering at 18 MeV, optical-model parameter for
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CALCIUM-47—energy levels from calcium-48 (p,d) reactions
CALCIUM-46—energy levels from calcium-48 (p,t) reactions
CALCIUM-42—proton reactions (p,d) at 18 MeV, deuteron angular distributions from
CALCIUM-41—energy levels from calcium-42 (p,d) reactions
CALCIUM-48—proton reactions (p,d) and (p,t) at 18 MeV, angular distributions and spectra from
NEUTRONS—detection using silicon-28 (n,α) reactions
SILICON-28—neutron reactions (n,α) with, use in neutron detection
CALCIUM-42, SCANDIUM-45, TITANIUM-46, TITANIUM-50—proton reactions (p,α) at 18 MeV, α angular distributions and spectra from
PROTONS—scattering at small angles, method for measuring inelastic
NUCLEI—mass relations
NUCLEAR MODELS (SHELL)—theory of second-order corrections for particle-hole interaction
OXYGEN-16—energy levels of, correlation energy for
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NICKEL-59—energy levels from neutron reactions with nickel-58, intermediate structure
NICKEL-61—energy levels from neutron reactions with nickel-60, intermediate structure
NUCLEI—nucleon interactions in 2s1d shell, calculations using SU(3) representation
CALCIUM-40—energy levels of, calculations using Tamm-Dancoff and random-phase approximations for odd-parity
MATTER—nuclear interaction potential for nuclear, density-dependent
OXYGEN-16—energy levels in giant dipole resonance region, monopole
NUCLEI—reaction matrix elements for A = 50 and 90, calculations using Hamada-Johnston interaction
FLUORINE-18, OXYGEN-16, OXYGEN-17, OXYGEN-18—energy levels of, calculations using shell model with Reid, Yale, and Hamada-Johnston potentials
NUCLEAR MODELS (SHELL)—potentials for, comparison of Reid, Yale, and Hamada-Johnston
NUCLEI—energy levels of neighboring, single-hole and single-particle
LEAD-208—energy levels in giant resonance region, calculations using Hamada-Johnston potential
NUCLEAR MODELS (SHELL)—reaction matrix elements in, method for calculating
NUCLEI—binding energies of $f_{\frac{7}{2}}$-shell
VANADIUM-51—nuclear electric quadrupole moment of ground state of
FLUORINE-18—energy levels of, description of
NUCLEI—description of A = 15 and 17, including deformed states
MESIC ATOMS—nuclear polarization effect in μ^-
NUCLEAR REACTIONS—theory of channel coupling in
NEUTRONS—scattering by carbon-12 at low energy, calculations using coupled-channel formalism
CARBON-12—neutron scattering at low energy, calculations using coupled-channel formalism
NUCLEI—deformation of even-even A = 8 to 36, calculations using variational method
CYCLOTRONS—development of Princeton AVF
VACUUM GAGES—development of, using thermistor (D.C.W.)

38378 (USNRDL-TRC-67-27) RADIOACTIVE DISINTEGRATION AS A SUBSIDENCE PROCESS. Langer, R. M. (Naval Radiological Defense Lab., San Francisco, Calif.). Apr. 17, 1967. 41p. CFSTI.

The representation of fission-product activity as the Laplace Transform of decay-constant distribution functions is studied and applied to idealized, empirical, and fractionated isotope distributions. It is also shown how the Inverse Transform may be used to draw conclusions about radioactive mixtures from measured decay curves. (auth)

38379 A STUDY OF THE DOPPLER INTEGRAL IN REGIONS OF PHYSICAL INTEREST. Arad, B.; Ben-David, G.; Schlesinger, Y. (Atomic Energy Commission, Yavne, Israel. Bar-Ilan Univ., Ramat-Gan, Israel). Nucl. Instrum. Methods, 53: 277-84(1967).

The Doppler integral $\psi(x,t)$ defined in the text was calculated to a precision better than one part in 10^6 for values of x up to 2×10^5 and t up to 2.5×10^7, using a very simple application of the Simpson sum rule. The method is particularly suited to com-

puter solutions of problems involving the evaluation of the Doppler integral, such as are found in analysis of self-absorption experiments with resonantly scattered gamma radiation. New modified Doppler and Lorentz approximations for the integral were derived which give a much higher degree of accuracy than the usual approximations. (auth)

38380 EXPERIMENTAL STUDY OF DEFORMATION OF β SPECTRA EMITTED BY THICK SOURCES. Voljin, Valentina; (Univ., Bucharest); Ciangiru, Gh.; Postelnicu, C. Rev. Roum. Phys., 12: 149-57(1967). (In French).

An experimental method is proposed for the correction of the β spectra deformed by the support and the finite thickness of the source. The method proposed is more general than and includes the method of experimental study of the β spectrum used by Quivy and Franeau as a particular case. By use of a magnetic β spectrometer the correction of the β spectrum of a ^{45}Ca source of thickness 56 mg/cm^2 deposited on a polystyrene support of 15 μg/cm^2 was made. (tr-auth)

38381 TENSOR-FORCE, HARD-CORE, AND THREE-BODY PARAMETERS. Schrenk, G. L. (Univ. of Pennsylvania, Philadelphia); Mitra, A. N. Phys. Rev. Lett., 19: 530-2(Aug. 28, 1967).

Results are presented for the binding energy of ^{3}H and the doublet n-d scattering length (α_t) using a rank-four separable potential which simulates the hard core as well as the tensor force. The binding energy is nearly four times the deuteron binding energy, and α_t is 0.13–0.18 F for the best available $^1S_0$ potentials, in close agreement with the latest experimental value. (auth)

38382 MONTE CARLO CALCULATION FOR DOUBLE-SCATTERING CORRECTIONS TO THE ANGULAR DISTRIBUTION OF ELASTICALLY AND INELASTICALLY SCATTERED FAST NEUTRONS. Bressani, Tullio (Univ., Cagliari, Italy). Atti Accad. Sci. Torino I, Cl. Sci. Fis., Mat. Natur., 101: 329-45 (1966-1967). (In Italian).

A Monte Carlo calculation to determine the effect of double scattering in a fast neutron scattering experiment is described. The method makes it possible to correct the angular distribution of the experimentally measured elastic and inelastic scattering. The results obtained for the case of the angular distribution of 14-MeV neutrons scattered by ^{31}P are reported. (tr-auth)

38383 THREE-NUCLEON FORCE. Loiseau, B. A.; Nogami, Y. (McMaster Univ., Hamilton, Ont.). Nucl. Phys., B2: 470-8(1967).

The expectation value of the two-pion-exchange three-body potential in the triton is estimated. The triton wave function is taken from a variational calculation with a hard-core two-nucleon potential. The effect of the (controversial) I = J = 0 dipion resonance (the σ-meson) is considered. The three-body potential consists of three parts: $W = W_p + W_s + W_\sigma$, where W_σ is due to the (virtual) π-N scattering via the σ-meson, while W_p and W_s are due respectively to the p-wave and s-wave π-N scattering via "direct interactions." The direct s-wave π-N interaction is set up so that, together with the π-N interaction via the σ-meson, it reproduces the observed s-wave π-N scattering length. Since it is rather meaningless to consider the two-pion-exchange potential alone at short distances, a cut-off distance d is introduced, and the three-body potential is set to be zero for distances less than d. The result is sensitive to d and also the hard-core radius D of the two-body potential. For instance, for D = 0.4 fm, the contribution to the binding energy can be as big as about 1 MeV (attractive). Effects of the three-body force in nuclear matter are also discussed briefly. (auth)

38384 STRUCTURE OF THE TRINUCLEONS. Gibson, Benjamin F. (Univ. of California, Livermore). Contract W-7405-eng-48. Nucl. Phys., B2: 501-17(1967). (UCRL-70428).

The trinucleon elastic electron scattering form factors and two-body photodisintegration cross section data were re-examined with the object of determining a single wave-function description of the nuclei consistent with both experiments. A two-parameter S-state radial function containing a core was found to provide a satisfactory fit when a 2% S' state and a 6% D state were included. The admixed states were assumed to have the same radial dependence as the asymptotic part of the S state. The two-body electrodisintegration of ^{3}He, the radiative neutron capture by deuterium, the μ-capture by ^{3}He and the neutron charge form factor are also discussed in the light of this proposed wave function. (auth)

38385 APPROXIMATION FOR ELECTRONIC ENERGY LOSS BY FISSION FRAGMENTS. Mulas, Pablo (Instituto Politecnico Nacional, Zacatenco, Mexico); Axtmann, Robert C. Trans. Amer. Nucl. Soc., 10: 44(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38386 APPLICATION OF THE COMPOSITE NUCLEAR LEVEL-DENSITY FORMULA TO THE PREDICTION OF CROSS SECTIONS FOR CHARGED-PARTICLE EMISSION. Goodwin, Diane A.; Carter, H. G. (General Dynamics/Ft. Worth, Tex.). Trans. Amer. Nucl. Soc., 10: 227(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38387 EFFECTS OF THE DEUTERON D STATE AND J DEPENDENCE IN (d,p) AND (p,d) REACTIONS. Johnson, R. C.; Santos, F. D. (Univ. of Surrey, London). Phys. Rev. Lett., 19: 364-6(Aug. 14, 1967).

It is shown that the D component of the deuteron internal wave function gives rise to corrections to the direct-reaction theory of (d,p) and (p,d) reactions which depend strongly on the angular momentum of the transferred neutrons. For an orbital angular momentum transfer of 3, the corrections are large and give an important contribution to the J dependence observed in the reactions ^{56}Fe(p,d)^{55}Fe and ^{57}Ni(p,d)^{56}Ni. (auth)

38388 CRITIQUE OF THE METHOD OF MEASUREMENT OF MAGNETIC MOMENTS OF NUCLEI EMBEDDED IN FERROMAGNETIC FOILS. Ben-Zvi, I.; Gilad, P.; Goldring, G.; Hillman, P.; Schwarzschild, A.; Vager, Z. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev. Lett., 19: 373-6(Aug. 14, 1967).

Anomalous magnetic fields have been found to exist at the sites of nuclei embedded, by recoil from Coulomb excitation, into iron and nickel foils, of such a nature that for considerable time intervals the large magnetic fields at the stopped nuclei are not parallel to the external magnetic fields. The reliability of this method of measuring nuclear g factors is therefore in considerable doubt. A model of the magnetic-field distribution is presented, but the mechanism which produces this distribution is not understood in detail. (auth)

38389 POSSIBLE SPIN DEPENDENCE OF DIRECT REACTIONS ON LIGHT NUCLEI. Siemssen, R. H. (Yale Univ., New Haven); Dehnhard, D. Phys. Rev. Lett., 19: 377-80(Aug. 14, 1967).

It is shown that recently observed systematic differences in the shapes of the angular distributions of single-nucleon-transfer reactions on light nuclei are probably correlated with the spins of the final states. (D.C.W.)

38390 EXACT EIGENVALUES OF AN ISOPAIRING HAMILTONIAN IN A SINGLE-j SHELL. Camiz, P. (Istituto Nazionale di Fisica Nucleare, Rome. Univ., Rome. Institut de Physique Nucleaire, Orsay, France). Nuovo Cim. (10), 50B: 401-4(Aug. 11, 1967).

A procedure for diagonalizing an interaction which is active between pairs of nucleons in states with T = 0 and odd J is discussed. Such an interaction is frequently called an isospin pairing Hamiltonian. The procedure considered is analogous to one in which a charge-independent pairing Hamiltonian between nucleons can be exactly diagonalized. (J.F.P.)

38391 INTERFERENCE BETWEEN PROMPT AND DELAYED PROCESSES OF NUCLEAR REACTIONS. Olkhovski, V. (Univ., Milan). Nuovo Cim. (10), 50B: 392-4(Aug. 11, 1967).

It is shown that the interference mechanism between prompt and delayed final wave packets depends not only on the collision dynamics but also on the initial wave packet length and on the grade of the dispersion which is usually not taken into account. (D.C.W.)

38392 THREE-NUCLEON STRIPPING PROCESSES. El-Nadi, M. (Cairo Univ.); Ismail, Y. M.; Rihan, T. H. Nuovo Cim. (10), 50B: 224-37(Aug. 11, 1967).

The three-nucleon stripping process is considered, taking into account the individual character of the captured nucleons. It is found that the relative angular momenta of these nucleons have large effects on the shape and magnitude of the differential cross section as the incident energy increases. The reaction ^{9}Be(α,n$_0$)^{12}C is considered, and the effect is studied as a function of the energy of the projectile. Good agreement with the experimental data is obtained in cases when the earlier stripping treatment does not give satisfactory results. (auth)

38393 SPECTROSCOPIC FACTORS FOR THE 1p SHELL. Cohen, S.; Kurath, D. (Argonne National Lab., Ill.). Nucl. Phys., A101: 1-16(1967).

Spectroscopic factors are given for single-nucleon transfer reactions in the 1p shell. The calculations are based on effective interactions deduced previously. The strength for such reactions is found to lie in relatively few states of the adjacent nuclei. Sum

rules indicate the degree of intermediate coupling of the representation. (auth)

38394 TIME-DEPENDENT SCATTERING FORMALISM. Jeukenne, J. P. (Univ. of Liege). Nucl. Phys., A101: 229-40 (1967).

A method for analyzing in terms of resonance states the time dependence of wave packets corresponding to the elastic scattering of neutral particles by any real potential of finite depth and range is derived from a Cauchy expansion in terms of the poles of the collision matrix. Wave packets so obtained are well adapted to numerical computations. (auth)

38395 STABILITY OF $^{298}114$ AGAINST FISSION. Wong, Cheuk-yin (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev. Lett., 19: 328-30(Aug. 7, 1967). (ORNL-P-3173).

The formalism of Siemens and Bethe concerning the stability of $^{298}114$ gives different conclusions depending on the mass formula used in obtaining the fissionability parameter. (auth)

38396 ON THE DIFFRACTION SCATTERING OF PARTICLES WITH SPIN 1/2. El-Wakil, S. A.; Kresnin, A. A. (Atomic Energy Establishment, Cairo). Z. Phys., 204: 339-44(1967).

The differential cross section and polarization of spin-$\frac{1}{2}$ particles are calculated using the method of complex angular momenta on the assumption that both the scattering function $\eta(l)$ and nuclear phase shift $\delta(l)$ have poles in the complex l-plane. The Coulomb effects are considered. Qualitative agreement with experiment was obtained. (auth)

38397 QUASIPARTICLE DESCRIPTION OF NUCLEI. Mueller, Dieter (Technische Hochschule, Hanover). Z. Phys., 204: 384-404(1967).

The T-operator of a stable N-nucleon system is expressed by means of a renormalizable equation. This equation is derived without any approximations on the basis of Weinberg's quasi-particle theory. Its application to a certain model system yields equations which are very similar to the basic equations used by Midgal and Larkin in their phaenomenological theory of nuclear structure. It can be shown, however, that this model system approximates the N-nucleon system only in a restricted energy region which is different from the region of validity postulated in the theory of Migdal and Larkin. The reason for this contradiction is the fact that the unperturbed model has discrete eigenstates. (auth)

38398 ON THE NUCLEAR OCTUPOLE DEFORMATION IN THE $218 \leq A \leq 232$ REGION. Vogel, P. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Phys. Lett., 25B: 65-7(Aug. 7, 1967).

The potential energy of a nucleus is expressed as a function of parameters of the quadrupole and octupole deformation. The minimum for all nuclei in the given region appears at $\beta_3 = 0$, i.e., there exist no nuclei with a stable octupole deformation. An asymmetry is observed of the $E(\beta_2,\beta_3)$ surface towards the $\beta_2 = \beta_{equilibrium}$ plane which should be interpreted as an interaction of β-vibrations and octupole vibrations. (auth)

38399 THE 2-PARTICLE TRANSFER REACTION WITH T = 1 PARTICLE-HOLE STATES. Bertsch, G. F. (Princeton Univ., N. J.). Phys. Lett., 25B: 62-5(Aug. 7, 1967). (PUC-937-265).

In contrast to many types of reactions, the two-particle transfer reaction leading to T = 1 particle-hole states shows an inhibition to the ground-state and coherent enhancement to excited states. (auth)

38400 A NOTE ON REARRANGEMENT ENERGY. Elton, L. R. B. (Univ. of Surrey, London). Phys. Lett., 25B: 60-2 (Aug. 7, 1967).

The Brueckner re-arrangement energy in light closed shell nuclei is estimated using wavefunctions in a Saxon-Woods well that fit electron scattering and proton separation energies. In contrast with previous work, the energy is approximately constant at 5 to 6 MeV per particle. (auth)

38401 THE EFFECT OF THREE-BODY FORCES IN ^{3}H. Pask, C. (Univ. of New South Wales, Kensington, Australia). Phys. Lett., 25B: 78-80(Aug. 7, 1967).

The results of calculations of the contribution of three-body forces to the binding energy of ^{3}H are reported. These suggest that such forces may be of considerable importance in nuclear physics. (auth)

38402 STRENGTH DISTRIBUTIONS. French, J. B.; Hsu, L. S. (Univ. of Rochester, N. Y.). Phys. Lett., 25B: 75-8 (Aug. 7, 1967).

Methods are given for studying the strength distributions for operators which act in or between vector spaces of fermions distributed over a finite set of single-particle states. Some elementary applications to particle, hole, and hole-particle excitations are discussed. (auth)

38403 ACCURATE CALCULATION OF THE REACTION MATRIX IN LIGHT NUCLEI. Kallio, A.; Day, B. D. (Argonne National Lab., Ill.). Phys. Lett., 25B: 72-4(Aug. 7, 1967).

An improved Eden-Emery method is developed to solve the Bethe-Goldstone equation virtually exactly. The equation is first written in the form of an integro-differential equation. The solution is constructed with the aid of a sequence of inhomogeneous differential equations of second order. The resulting t-matrix elements are then used to perform a self-consistent calculation of the binding energy of ^{4}He and ^{16}O. For ^{4}He a few of the lowest order Goldstone diagrams are also evaluated. The result differs by less than 0.5 MeV/A from the value obtained with variational calculations for the same interaction. (auth)

38404 SATURATION IN HARTREE–FOCK CALCULATIONS USING DENSITY-DEPENDENT FORCES WITH HARD CORES. Lande, A.; Svenne, J. P. (Univ. of Copenhagen). Phys. Lett., 25B: 91-4(Aug. 7, 1967).

The results of Hartree-Fock calculations for ^{16}O are given. The following nucleon-nucleon potentials were examined: Hamada-Johnston, Kallio-Kolltveit, and the Kallio-Kolltveit interaction modified by the dependence on local density suggested by Bethe. The infinite repulsive core is treated in the separation method for even states of the Hamada-Johnston and Kallio-Kolltveit potentials, and in the reference spectrum method for the odd states of the Hamada-Johnston potential. The density dependence increases the energy from over- to underbinding. It also leads to much better agreement of the calculated radius with electron scattering data. (auth)

38405 POSSIBLE OBSERVATION OF VACUUM POLARIZATION EFFECTS IN THE $^1S_0$ p–p STATE. Slobodrian, R. J. (Univ. of California, Berkeley). Phys. Lett., 25B: 89-90(Aug. 7, 1967).

The effects of vacuum polarization on the "line shape" of the $^1S_0$ p-p state are calculated and are shown to be measurable with present experimental techniques. (auth)

38406 MAGNITUDE OF ALPHA-DECAY RATES. Scherk, L.; Vogt, E. W. (Univ. of British Columbia, Vancouver). Phys. Lett., 25B: 86-9(Aug. 7, 1967).

It is shown that the discrepancy between the absolute magnitude of alpha-decay rates observed in heavy nuclei and the corresponding rates calculated with the nuclear shell model can be largely removed by a direct treatment of the average interaction between the alpha-particle and the residual nucleus. (auth)

38407 UNITARY MODIFICATION OF THE IMPULSE-PICKUP APPROXIMATION. Sloan, I. H. (Univ. of New South Wales, Kensington, Australia). Phys. Lett., 25B: 84-5(Aug. 7, 1967).

A unitary modification of the impulse-pickup approximation for three-body bound-state scattering and rearrangement collisions is proposed. Calculations on a soluble model yield good agreement with the exact results. (auth)

38408 EFFECTS OF A SPIN-DEPENDENT INTERACTION POTENTIAL IN THE DWBA ANALYSIS OF TWO-NUCLEON TRANSFER REACTIONS. Hardy, J. C.; Towner, I. S. (Oxford Univ.). Phys. Lett., 25B: 98-102(Aug. 7, 1967).

The introduction of spin-exchange terms in the interaction is shown to reduce both (p,t) and (p,^{3}He) cross sections. The S = 1 and S = 0 terms in the expression for (p,^{3}He) still add incoherently but the relative strength of the former is reduced. Comparison with experiment shows satisfactory agreement. (auth)

38409 ON THE CONTINUOUS EIGENVALUES OF THE LIPPMANN–SCHWINGER OPERATOR K(W). Mueller, Dieter (Technische Hochschule, Hanover). Z. Phys., 204: 254-61 (1967).

The continuous eigenvalues of the Lippmann–Schwinger operator $K(W) = G_0(W) \cdot V$ at real negative energy W are investigated. It is shown that for energies in the stability region of the system the continuous spectrum is located inside the unit circle. As an application of this result, a method for computing the ground-state energy of a three-nucleon system is described. (auth)

38410 STRUCTURE OF ISOBARIC ANALOG STATES IN HEAVY NUCLEI. Zaretskii, D. F.; Urin, M. G. (Moscow Engineering-Physics Inst.). Zh. Eksp. Teor. Fiz., 53: 324-30 (July 1967). (In Russian).

The microscopic structure of analog states in heavy nuclei are treated by the interacting quasi-particle method. The relation between the microscopic approach and the description by means of isotopic spin is established. The optical width of the analog states is estimated. (auth)

38411 REGULARIZATION AND PERATIZATION OF SINGULAR POTENTIALS. Gale, William A. (Rice Univ., Houston, Tex.). J. Math. Phys., 8: 1050-2(May 1967). (ORO-1316-14).

It is proven that the commonly used regularizations for singular potentials are successful. This means that one can investigate the peratization properties with confidence. A general argument for the success of peratization, as an approximation procedure, is presented. The class of failures of peratization is extended to a series of arbitrarily weakly singular perturbations on the inverse fourth potential. The two results present an unresolved contradiction; some resolutions are considered. (auth)

38412 THE UNIFIED THEORY OF NUCLEAR REACTIONS. III. OVERLAPPING RESONANCES. Feshbach, Herman (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Ann. Phys. (N. Y.), 43: 410-20(July 1967). (MIT-2098-292).

The unified theory of nuclear reactions is used to derive general expressions which are valid in the presence of direct interactions as well as separated or overlapping compound nuclear resonances; explicitly satisfy the requirements of unitarity; and involve the minimal number of real parameters. (auth)

38413 COUPLED CHANNELS AND THEIR APPLICATION TO RESONANCES IN THE SCATTERING OF LOW-ENERGY NEUTRONS BY ^{12}C. Roeder, John L. (Princeton Univ., N. J.). Ann. Phys. (N. Y.), 43: 382-409(July 1967). (PUC-937-228).

Low-energy ^{12}C-neutron scattering is considered as an example of channel coupling in nuclear reactions. In coupled-channel computer calculations of this reaction, particular attention was paid to resonances from the viewpoint of scattering cross sections, eigenphase shifts, and poles of the transition matrix as selected scattering parameters are varied. Many of these resonances are seen to arise from channel coupling. Wherever possible, the results of these calculations are compared with analytic results which have been obtained only for special cases. A concluding analysis includes a discussion of the behavior of resonances near channel thresholds. (auth)

38414 STUDIES IN ISOBARIC ANALOG RESONANCES. I. GROSS PROPERTIES. de Toledo Piza, A. F. R.; Kerman, A. K. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Ann. Phys. (N. Y.), 43: 363-81(July 1967). (MIT-2098-319).

The gross structure of isobaric analog resonances in the N, Z + 1 system is described in terms of the intermediate structure associated with the analogs of the low-lying states of the N + 1, Z nucleus. These analog states are shown to act as "doorway states" of a rather special nature in producing generally asymmetric gross anomalies in the elastic and inelastic scattering. This description leads to a mold-independent parametrization of the isobaric analog resonances. A discussion of (p,n) processes involving isobaric analog resonances is also given. (auth)

38415 NUCLEAR MAGNETIC MOMENT. Bow, Y. F. (Univ. of Western Ontario, London). Phys. Rev., 159: 775-6(July 20, 1967).

A systematic estimate of the magnetic-moment correction due to spin-orbit interaction in deformed nuclei is presented, which may be of interest in evaluating the significance of this magnetic-moment correction. (auth)

38416 COMPARISON OF MODERATE-ENERGY PROTON-PROTON MODELS. III. Noyes, H. Pierre (Stanford Univ., Calif.); Signell, Peter; Yoder, N. R.; Wright, Robert M. Contract W-7405-eng-48. Phys. Rev., 159: 789-92(July 20, 1967). (UCRL-70349; SLAC-PUB-269).

The predictions of 12 proton-proton models and phase-shift representations are compared to a selected but comprehensive set of 9 to 330-MeV scattering data. The best fit was found to be produced by a quadratic interpolation of Arndt and MacGregor's phase-shift table, with a ratio of χ^2 to its expected value of 1.4. The best potential is that of Hamada and Johnston, with a ratio of 3.1. The ratio for the Tabakin potential is 28. (auth)

38417 TWO-PION-EXCHANGE THREE-BODY Λ-NUCLEON INTERACTION IN NUCLEAR MATTER. Nyman, Ebbe M. (Stanford Univ., Calif.). Contract AF49(638)-1389. Phys. Rev., 159: 782-9(July 20, 1967).

The two-pion-exchange three-body Λ-nucleon force is considered in nuclear matter. The $\pi-\Lambda$ interaction is consistent with the known hyperon resonances, and contributions from the Σ channel are included without neglecting the $\Sigma-\Lambda$ mass difference. Nuclear correlations produced by tensor forces and hard cores are included, as well as the exchange terms, which arise from the antisymmetrization of the nuclear wave functions. The Λ and Σ hyperons are also assumed to have hard cores. The contribution to the potential energy of a Λ hyperon in nuclear matter is found to be 3.6 MeV (repulsion). This number is an overestimate since part of the Λ-N short-range correlations were neglected. Because of its strong density dependence, the contribution in light hypernuclei is probably fairly unimportant. (auth)

38418 EIGENSTATES OF THE L = 0, CHARGE- AND SPIN-INDEPENDENT PAIRING HAMILTONIAN. I. SENIORITY-ZERO STATES. Richardson, R. W. (New York Univ., New York). Phys. Rev., 159: 792-805(July 20, 1967).

Equations for all the seniority-zero eigenstates of 2N nucleons in an arbitrary charge- and spin-independent potential well and interacting through charge- and spin-independent pairing forces are derived. These equations are solved exactly for a large number of states of this system. The interaction in this Hamiltonian is effective in the L = 0 states of the two-nucleon system, and its strength is independent of the remaining quantum numbers of the two nucleons. The equations are solved exactly for those states whose wave functions are totally symmetric functions of the spin-isospin coordinates of the N L = 0 pairs of nucleons in the state. The wave functions of these states factor into a spin-isospin-dependent part and a spatially dependent part. The spin-isospin-dependent part of one of these wave functions is an eigenvector of three tridiagonal matrices which ensure that the state is a spin, isospin, and supermultiplet eigenstate, respectively. Explicit expressions are given for the eigenvalues of these three matrices in terms of the quantum numbers of the state. The spatially dependent part of one of these wave functions is given explicitly in terms of N parameters which we call pair energies. These pair energies are shown to satisfy N coupled algebraic equations which depend parametrically upon the supermultiplet quantum numbers of the state. An expression for the occupation probabilities of the levels of the single-particle well is given. Throughout this work, an arbitrary splitting of the single-particle levels is treated exactly. (auth)

38419 ELECTROMAGNETIC PROPERTIES OF NUCLEI CALCULATED FROM PROJECTED HARTREE–FOCK WAVE FUNCTIONS. Gunye, M. R. (Bhabha Atomic Research Center, Bombay); Warke, Chindhu S. Phys. Rev., 159: 885-91 (July 20, 1967).

Using the projected Hartree-Fock (HF) wave functions, a theoretical formulation is given for calculating the electromagnetic properties of nuclei, the nuclear form factors in electron scattering, ft values in β decay, and the reduced widths of nuclear levels in direct reactions. The formulation is applied to calculate the quadrupole and magnetic moments, the electromagnetic transition probabilities, and the lifetimes of nuclear levels of a large number of nuclei ranging from ^{19}F to ^{37}Cl in the 2s–1d shell. The good agreement between the calculated and the experimental values indicates a remarkable success of the projected HF functions in predicting the electromagnetic properties of nuclei. (auth)

38420 NUCLEAR MATRIX ELEMENTS FOR FORBIDDEN BETA DECAY OF SPHEROIDAL-SHAPED NUCLEI. Nguyen Duc Tuong; Dulaney, Harry; Brewer, H. R. (Georgia Inst. of Tech., Atlanta). Phys. Rev., 159: 862-8(July 20, 1967).

Theoretical expressions for both the nonrelativistic and relativistic nuclear matrix elements for β transitions of arbitrary forbiddenness are derived by using the Nilsson model. The β-decay operators are expressed in terms of irreducible spherical tensors. One- and two-particle intrinsic wave functions are used for odd- and even-mass nuclei, respectively. For even-mass nuclei, the results are found to be strongly dependent on the coupling of the two particles. The results are expected to be applicable to decays involving both intrinsic ground states and excited intrinsic states. The theoretical expressions are used to calculate matrix-element parameters for β decays in ^{170}Tm and ^{186}Re. The theoretical values are compared with experimentally determined values of the ^{170}Tm and ^{186}Re parameters. (auth)

38421 PHENOMENOLOGICAL Λ-NUCLEON POTENTIALS FROM s-SHELL HYPERNUCLEI. II. DEPENDENCE ON INTRINSIC RANGE. Herndon, R. C. (Univ. of California, Livermore); Tang, Y. C. Contract W-7405-eng-48. Phys. Rev., 159: 853-61(July 20, 1967). (UCRL-70053(Pt.2)).

By examining the binding-energy data of the s-shell hypernuclei and the $\Lambda-$proton scattering data with a number of effective central $\Lambda-$nucleon potentials of various hard-core radii (0–0.6 F) and intrinsic ranges (1.5–2.5 F), a $\Lambda-$nucleon potential was found which yields a very good fit to these experimental data. This potential has an intrinsic range of 2.1 F, a hard-core radius of 0.6 F, and an odd-parity-state strength which is equal to 60% of the even-parity-state strength. Also, it has a rather small degree of spin dependence in the Λ-proton case, with the consequence that the predicted J = 1 excited state in $_{\Lambda}H^4$ has a small excitation en-

ergy of only about 0.1 MeV. The Λ−proton effective-range parameters have the following values: $a_t^p = -2.08$ F, $r_{0t}^p = 3.40$ F, $a_s^p = -2.25$ F, and $r_{0s}^p = 3.29$ F. The case of Λ-neutron scattering was also considered. Here it is found that the total cross sections differ appreciably from those of the corresponding Λ-proton case only when the cms energy is less than about 4 MeV. (auth)

38422 SURFACE-DELTA-INTERACTION MODEL FOR NUCLEAR STRUCTURE ANALYZED BY PROTON INELASTIC SCATTERING. Faessler, Amand (Univ. of Freiburg i. B.); Glendenning, Norman K.; Plastino, A. Contract W-7405-eng-48. Phys. Rev., 159: 846-52(July 20, 1967). (UCRL-16976).

Differential cross sections and polarizations for 17.8-MeV protons scattered by nickel isotopes were calculated by solving the coupled equations. The nuclear states were described in terms of their microscopic composition in the two-quasiparticle approximation. Two such model calculations were used. The effect of the presence of pure "two-phonon" states was investigated by generating them from the collective operator for the 2_1^+ state. The effects of the spin-flip term in the direct interaction were included. Comparison of the results with experiments suggests that, except for the collective 2_1^+ state, the two-quasiparticle method is inadequate for treating nuclear states. The vibrational treatment also fails. A much more elaborate structure calculation which treats the mixing between the two-quasiparticle and the "two-phonon" configurations is suggested. (auth)

38423 INTERMEDIATE-COUPLING d-s SHELL STATES CLASSIFIED BY $R_3 \times R_3$. Vincent, C. M. (Univ. of the Witwatersrand, Johannesburg). Phys. Rev., 159: 869-74(July 20, 1967).

A group $R_9 \times R_9$ is found which can classify states of nuclear d-s shell configurations. The $R_9 \times R_9$ two-particle states are constructed and are found to exhibit strong intermediate coupling and configuration mixing of the d and s shells. They show considerable resemblance to states calculated by diagonalization of simple intermediate-coupling Hamiltonians. The lowest few levels of ^{18}O and ^{18}F are assigned to irreducible representations of $R_9 \times R_9$ in a consistent way. However, states within a given irreducible representation are not in rotational order, and states belonging to the same physical rotational band belong to different irreducible representations of $R_9 \times R_9$. It is therefore unlikely that the $R_9 \times R_9$ multiplets can be interpreted as rotational bands, although they have the correct angular momentum decomposition for $K \neq 0$ bands. (auth)

38424 ANGULAR MOMENTUM EFFECTS IN THE GAMMA-RAY DE-EXCITATION OF FISSION FRAGMENTS. Thomas, T. Darrah (Princeton Univ., N. J.); Grover, J. Robb. Contract AT(30-2)-Gen-16. Phys. Rev., 159: 980-4(July 20, 1967). (BNL-10437).

The energy dissipated as γ rays during the de-excitation of fission fragments (7.2 ± 0.8 MeV for ^{235}U thermal fission) is somewhat higher than has been estimated theoretically (4.9 MeV). It has been suggested that this discrepancy arises from the angular momentum of the fission fragments. A quantitative evaluation of this possibility was made, taking into account the angular momentum dependence of the level density, the nonexistence of levels of a given angular momentum below some minimum energy (yrast energy), and the competition between neutron and γ-ray emission. The initial angular momentum distribution is that derived from measurements of isomers produced in fission. Initial excitation energies are based on the known de-excitation properties of fission fragments. All other parameters were derived from sources having no direct connection with the fission process. The calculations for an average pair of fragments (^{96}Sr and ^{140}Xe) indicate that 7.1 MeV should appear as γ rays and that the average photon energy is 0.9 MeV. The calculated average neutron energy and number of neutrons are also in agreement with experiment. (auth)

38425 SEMI-INFINITE MATTER AND THE NUCLEAR SURFACE. Tabakin, Frank; Amos, Ken (Univ. of Pittsburgh). Nucl. Phys., A100: 574-608(1967).

The surface energy and thickness of semi-infinite nuclear matter are calculated by Swiatecki's variational method. Smooth, effective two-body interactions are used to study the relationship between the characteristics of each interaction and the predicted bulk surface properties. Both local and nonlocal Gaussian interactions are considered and are adjusted to either saturate infinite nuclear matter or to fit two-nucleon (singlet-even) phase shifts. Purely local potentials are found to give an excessively large surface energy (≈50 $A^{\frac{2}{3}}$ MeV), whereas potentials having some nonlocality (even if the nonlocality is confined to short distances) reduce the surface energy to a reasonable value of (20−30) $A^{\frac{2}{3}}$ MeV. The separate potential and kinetic energy contributions are examined in detail and are used to explain how the character of each interaction affects the surface properties. This model calculation shows that the surface energy is greatly influenced by nonlocality. Also, it is found that the predicted surface thickness tends to be too large ($t \approx 1.8$ fm) for potentials that are fitted to two-nucleon phase-shifts. (auth)

38426 NEUTRON THRESHOLDS TO RESONANT ANALOGUE STATES. Stephen, R. O. (Florida State Univ., Tallahassee). Nucl. Phys., A100: 689-96(1967).

The anomalous energy behavior of the neutron threshold to a resonant analog state is investigated in detail. The analysis is applied to recently studied reactions of the type A(d,np)A but can equally well be applied to reactions involving other projectiles. To avoid all three-body effects, the reaction is assumed to be a sequential process, i.e., the resonant intermediate analog state has a finite lifetime. An expression for the energy behavior at threshold is obtained. (auth)

38427 SOME EXTENSIONS OF THE COLLECTIVE OPTICAL MODEL FOR INELASTIC SCATTERING. Satchler, G. R. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Nucl. Phys., A100: 481-9(1967). (ORNL-P-3032).

It is suggested that the concept of collective oscillations of the optical-model potential be extended to more general shape oscillations and to oscillations involving the spins and isospins of the target nucleons. Some simple examples are discussed. A very simple model suggests that a phenomenological interaction with the same surface-peaked radial shape as that presently used would be reasonable also for excitation of spin and isospin oscillations. (auth)

38428 PARTICLE-HOLE INTERACTION AND CORE POLARIZATION. Sartoris, G.; Zamick, L. (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Lett., 25B: 5-8(July 24, 1967).

The discrepancy between particle-hole matrix elements of the nuclear interaction as obtained using a realistic two nucleon potential and as derived from experiment is partly but not completely removed by considering the effects of core polarization. Simple formulae for the corrections to the monopole interaction between a particle and a hole are given. (auth)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 35838, 35932, 35934, 36217, 36230, 36238, 36239, 36241, 36242, 36304, 36794, 36886, 36891, 36905, 38165, 38626, 38651, 38652, 38654, 38688, and 38826.

38429 (ACNP–67522) PATHFINDER ATOMIC POWER PLANT. PILE OSCILLATOR ROD ASSEMBLY, AND MEASUREMENTS OF REACTOR TRANSFER FUNCTIONS (432). Rudy, G. C.; Stone, J. T. (Allis–Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). July 1967. Contract AT(11-1)-589. 133p. Dep. CFSTI.

For Northern States Power Co., Minneapolis, Minn. and Central Utilities Atomic Power Associates.

An oscillator rod assembly was fabricated for the Pathfinder plant. The assembly and its components include the oscillator rod and drive mechanism and the associated instrumentation and recording equipment. Descriptions of the mechanism and related equipment, a summary of the test procedures, and results of the initial calibration tests performed at low power are described. (J.C.W.)

38430 (AECL–2670) RADIOLYTIC GAS PRODUCTION IN LIQUID CONTROL ELEMENTS FOR NUCLEAR REACTORS USING BORON AS THE ABSORBER. Mackintosh, W. D.; Atherley, J. A.; Dyne, P. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Apr. 1967. 42p. (CRCE–1257). Dep. CFSTI. CAN $1.50.

Any design proposal for the concept of liquid control elements using boron solutions as the absorber must take cognizance of the radiolytic gas production. The gas production will be greater than would be given by pure water because of the absorption of α particle and ^{7}Li recoil energy derived from the $^{10}B(n-\alpha)^7Li$ nuclear reaction. The radiolytic gas production rate is known for irradiations carried out in sealed quartz capsules. The experiments in which boron solutions were irradiated in the moderator Chemistry Loop (X-8) of NRX which simulates and actual operating device are described. It was found that the values obtained for the concentrations of the molecular products of radiolysis could be correlated with computer calculations based on a model which was derived from established concepts of the radiation chemistry of aqueous solutions. The model was then used to calculate the radiolytic gas pressure and evolution rates for B concentrations greater than could be accommodated in the loop. (auth)

38431 (AECL–2708) THERMALIZATION CALCULATIONS IN A CYLINDRICAL SHELL. Paper SM-96/90. Kushneriuk, S. A.; Kalman, C. S.; Malecki, A. M. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). July 1967. 20p. (CONF-670707–10). Dep. CFSTI. CAN $0.50.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich.

An approximate, semi-analytical procedure for determining the distribution and energy spectrum of the thermal and epithermal neutron flux in a weakly neutron capturing, cylindrical shell medium is considered. The shell medium is taken to represent the moderator surrounding a fuel rod in a thermal reactor. The basis for calculating the flux in most of the moderator is the energy dependent diffusion equation. Transient corrections to the diffusion approximation are added near the medium boundaries. The effects of adjoining media are taken into account through the boundary conditions imposed on the diffusion and transient fluxes. At the inner boundary these effects are calculated by collision probability methods. Activation fluxes are derived from the calculated neutron flux distributions and compared with measurements made in the D_2O moderator surrounding a uranium metal rod in the ZEEP reactor. (auth)

38432 (AI–CE–4) HEAVY WATER ORGANIC COOLED REACTOR. Quarterly Technical Progress Report, July–September 1965. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div. Atomics International, Canoga Park, Calif.). Aug. 15, 1967. Contracts AT(38-1)-383; AT(38-1)-386. 404p. Dep. CFSTI.

HEAVY WATER ORGANIC COOLED REACTOR—fuel elements for, hot-tube reference design for
REACTOR FUEL ELEMENTS—test loop for HWOCR, design parameters for; performance testing of urania; failure data on Zircaloy-4 clad; mechanical properties Zircaloy-4 clad; leak test results for HWOCR; clad materials compatibility with uranium carbide, evaluation of; hydraulic testing of HWOCR prototype; in-pile performance of uranium carbide; production of hyperstoichiometric HWOCR uranium carbide; fabrication of, economics of
REACTOR FUEL ELEMENT ASSEMBLIES—fabrication of HWOCR prototype; operating parameters for HWOCR prototype
IN-PILE LOOPS—operation parameters for HWOCR test; coolant flow characteristics in HWOCR test; operation history of MIT Reactor Organic
REACTOR FUELS—performance characteristics of uranium carbide, evaluation of
URANIUM CARBIDES—mechanical properties of, fuels of; processing of cylindrical fuel rods of, surface preparation method for
NRU REACTOR—radiation testing of HWOCR prototype uranium carbide fuels in
WHITESHELL REACTOR NO. 1—radiation testing of HWOCR prototype uranium carbide fuels in, design operation characteristics for
SAP(SINTERED ALUMINUM PRODUCTS)—creep data for SAP-930, biaxial; chemical analysis of; neutron activation analysis of, fast; tensile testing of irradiated and unirradiated tubing of
JOINTS—design of SAP-steel transition; fabrication data for SAP-steel; tensile test data for SAP-steel; fabrication data for rod-type transition; tensile test data for rod-type transition; tensile test data for flash welded SAP; development of hot pressed zirconium alloy–steel transition
ZIRCONIUM ALLOYS—joints of steel with, development of hot pressed transition; hydriding screening tests for HWOCR operating conditions for
STEELS—joints of zirconium alloys with, development of hot pressed transition
POLYPHENYL SYSTEMS—physical properties of Santowax OMP organic coolant; radiolysis kinetics in low-temperature steady-state conditions of; neutron effects on, low-temperature steady-state fast; radiopyrolysis rate constants for, high-temperature steady-state
HEAVY WATER ORGANIC COOLED REACTOR—coolant for, coolant molecular decomposition values for Santowax OMP; power distribution calculations for; spectral calculations as function of temperature for; physics parameter calculations using RBU Monte Carlo Code; fuel elements for, lattice cell parameters for clusters of; core parameters for, calculated values of; design parameters for 1000 MW(e); heat balance for plant; economics of, effects of high boiler content on; cooling system design for; coolant recovery system design data for; steam system design for; steam cycle efficiency calculation; nuclear instrumentation system block diagram for; economics of, fuel effects on; economics of, effects of coolant outlet temperature on; economics of, feed enrichment effects on; economics of, core length effects on; economic analysis of
LOOPS—operating parameters for film formation; design of Large Organic Test Facility (LOCTF)
PUMPS—performance of HWOCR coolant
EVAPORATORS—design data for HWOCR
SUPERHEATERS—design data for HWOCR
HEATERS—design data for HWOCR
REACTOR SAFETY—studies for HWOCR
REACTOR FUEL ELEMENTS—reprocessing of, economics of
ZIRCALOY—fuel element tubing of, mechanical properties of extruded finned
REACTOR LOADING MACHINES—design of HWOCR on-line (M.L.S.)

38433 (AI–CE–36) HEAVY WATER ORGANIC COOLED REACTOR. THE EFFECT OF SOME FABRICATION VARIABLES ON THE MECHANICAL PROPERTIES OF SINTERED ALUMINUM POWDER (SAP) SHAPES. Anderson, W. J.; Ferry, P. B. (Atomics International, Canoga Park, Calif. Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Aug. 15, 1967. Contract AT(38-1)-430. 44p. Dep. CFSTI.

Short-time tensile tests of rod, and tensile and tube-burst tests of tubing specimens of SAP alloys were conducted to provide preliminary information concerning the effects of thermal-mechanical history on mechanical properties. Quantitative correlation of the full fabrication processes with mechanical properties was precluded by lack of knowledge of the history of semifinished material. Comparison of effects of final fabrication indicated that mechanical properties of SAP are improved, to a point, during hot compressive working, and then might decrease when a critical degree of working is exceeded. Tube-burst test results indicated that the presence of longitudinal fins on SAP fuel cladding tube neither increases nor decreases its inherent strength in a short-term test. The difference in deformation, and the fracture loca-

tion in tube-burst tests of cladding tube with fins removed, indicates a difference in mechanical behavior of the tube wall under fins and the tube wall between fins. The difference in behavior is attributed to differences in the mechanical working of the areas. (auth)

38434 (APDA-197) QUARTERLY TECHNICAL PROGRESS REPORT ON AEC-SPONSORED ACTIVITIES, OCTOBER 15-DECEMBER 15, 1966. (Atomic Power Development Associates, Inc., Detroit, Mich.). Contract AT(11-1)-865. 74p. Dep. CFSTI.

Measurements on surface temperatures occurring during a Na–water reaction are presented. Preparation and modifications of test equipment are detailed. Investigations into the cause of wastage are discussed; wastage surface temperature measurements are tabulated. A summary of Na technology loop operations is presented. A detailed evaluation of rheometers and O_2 waters is given. Results of Na sampling and analysis are tabulated. Development of the high speed centrifuge for Na analysis is outlined. Water–Na scanner development is discussed briefly. An outline of Fermi Fast Breeder operating experience is given. (M.L.S.)

38435 (APDA-204) QUARTERLY TECHNICAL PROGRESS REPORT ON AEC-SPONSORED ACTIVITIES, DECEMBER 15, 1966–MARCH 15, 1967. (Atomic Power Development Associates, Inc., Detroit, Mich.). Contract AT(11-1)-865. 63p. Dep. CFSTI.

Sodium-water reaction studies are detailed. Test equipment is described; procedures are outlined; results are discussed. The use of the Na technology loop is outlined. Rheometer response to impurities in the Na is presented; oxygen water response to impurities in the Na is tabulated; H_2 water operation is discussed. Development of the under-Na scanner is outlined. An outline of Fermi Fast Breeder operating experience is given. FFTF support work is outlined. (M.L.S.)

38436 (APDA-205) POTENTIAL APPLICATIONS FOR AN UNDER-SODIUM ULTRASONIC SCANNING DEVICE. Scott, C. C.; Huebotter, P. R.; Callen, R. C. (Atomic Power Development Associates, Inc., Detroit, Mich.). July 1967. Contract AT(11-1)-865. 38p. Dep. CFSTI.

Previous AEC-sponsored development work on various concepts of under-Na scanning devices has resulted in the selection of a single approach that represents the best compromise of simplicity, flexibility, range, and resolution. In the context of the capabilities and limitations of this approach, which employs a narrow-beam ultrasonic transducer with a metallic focusing lens operable in Na at 600°F, numerous applications in existing and future Na-cooled reactors and associated research and development projects are possible. A survey of these applications has been made, evaluated, and reduced to a single demonstration objective which represents a common denominator of most of the applications of greatest potential interest in the Liquid Metal Fast Breeder Reactor (LMFBR) development program. This demonstration, which could be first pursued in an out-of-pile mockup facility and then be followed by a demonstration in an existing Na-cooled reactor, is defined in this report as the recommended near-term goal for a follow-on development effort. (auth)

38437 (APDA-CFE-10) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT. Monthly Report No. 10, May 1967. McCarthy, J. F. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich. Detroit Edison Co., Mich.). July 1967. Contract AT(11-1)-865. 30p. Dep. CFSTI.

An operations history of the Fermi Fast Breeder Reactor is given. Shipment of subassembly M140 to Battelle hot labs for inspection is discussed. Shop testing of the new fuel transfer facility is outlined. Results of the MO91 subassembly, already inspected at Battelle, are given. The Na cleanup system is discussed; testing of the primary Na plugging indicator is outlined. (M.L.S.)

38438 (BMI-1810) AN EVALUATION OF THE APPLICABILITY OF EXISTING DATA TO THE ANALYTICAL DESCRIPTION OF A NUCLEAR-REACTOR ACCIDENT. Quarterly Progress Report, April–June 1967. Morrison, David L.; Basham, Samuel J.; Blutreich, Joachim N.; (and others) (Battelle Memorial Inst., Columbus, Ohio). July 1, 1967. Contract W-7405-eng-92. 41p. Dep. CFSTI.

Accident heat-transfer calculations were made for blowdown conditions in a PWR. Effects of variation of surface heat-transfer coefficients for fuel rods are discussed. The time required for Zircaloy cladding to reach its melting point is presented as a function of reciprocal heat-transfer coefficient. Steam-metal reactions are neglected. Stress calculations and temperature drop calculations across the cladding are shown for blowdown conditions. Zircaloy-4 tubing burst pressure is calculated as a function of temperature. Emergency core cooling systems are evaluated. A fission-product calculational model is presented. Fission-product deposition in-core is calculated; calculations of fission-product transport and deposition in the plenum are presented. Calculation parameters for fission-product transport and deposition in containment vessels are tabulated. Calculations of electrostatic charge on rate of particle deposition is discussed. The efficiency of single-droplet collection is presented as a function of particle size. (M.L.S.)

38439 (BMI-X-10193) FISSION-PRODUCT DEPOSITION AND ITS ENHANCEMENT UNDER REACTOR ACCIDENT CONDITIONS. Quarterly Progress Report, January–March 1967. Genco, Joseph M.; Berry, David A.; Berry, Warren E.; Rosenberg, Harvey S.; Cremeans, George E.; Morrison, David L. (Battelle Memorial Inst., Columbus, Ohio). Apr. 1, 1967. Contract W-7405-eng-92. 65p. (EURAEC-1847). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Pressure vessel adsorption measurements are discussed. Coefficients for the rate of iodine deposition on prefilmed Type 304 stainless tubes are presented. The mathematical model used for data analysis is described. A graph shows theoretical deposition profiles for comparison with experimental data. Experimental data for low velocity flow system tests using prefilmed flat Zircaloy-4 and Type 304 stainless steel are summarized. Rate-coefficient dependence on temperature is shown. Vapor-phase iodine adsorption and desorption on various containment systems coatings are detailed. These coatings include phenoline 368, Amercoat 33HB, and phenoline 302. Vapor-phase deposition of iodine on painted surfaces is tabulated. Effects of temperature and concentration on iodine deposition are shown. Deposition of elemental iodine on Fe, Ni, Cr, Pt, and 304 stainless is detailed. Temperature effects of elemental iodine deposition on 304 stainless is tabulated. Average gas-phase mass-transfer coefficients for iodine in a steam/air mixture are calculated. Data on liquid phase deposition of elemental iodine on containment system coatings under varying conditions are tabulated. Iodine sorption data for various coating materials are presented. Methyl iodide absorption data for various coating materials are tabulated. (19 references.) (M.L.S.)

38440 (BNL-50044) THE ORDERED BED BREEDER REACTOR. Brookhaven Lecture Series Number 43. Winsche, Warren E. (Brookhaven National Lab., Upton, N. Y.). Jan. 20, 1965. 9p. Dep. CFSTI.

Conditions in the settled bed reactor are a compromise between those in the solid fueled and homogeneous reactors. The settled bed system is a better compromise than the paste reactor. The settled bed system is simpler and avoids the circulation of fission products. The fabrication of the beads for the ordered bed, or settled bed, reactor becoming economically feasible is discussed. The availability of reactor fuels and projected usages is summarized. (J.C.W.)

38441 (BNWL-429) PACTOLUS: A CODE FOR COMPUTING NUCLEAR POWER COSTS. PART 1. USER'S MANUAL. Nail, J. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1967. 88p. Dep. CFSTI.

The operation manual for applying the PACTOLUS computer code is presented. The PACTOLUS computer code is programmed for the UNIVAC 1107 in FORTRAN IV language to be used in computing nuclear power costs. Appendices include a listing of the PACTOLUS computer program, data on nuclear power costs as calculated by the computer code, and a listing of all computer programs used in making the PACTOLUS code. (D.C.C.)

38442 (BNWL-SA-1193) MATERIALS CONSIDERATIONS FOR WATER-COOLED POWER REACTOR SYSTEMS. Claudson, T. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 3, 1967. Contract AT(45-1)-1830. 61p. (CONF-671007-1). Dep. CFSTI.

For Presentation at International Nickel Company Power Conference, Lausanne, Switzerland.

The selection of materials for reactor application depends upon mechanical properties, fabricability, availability, compatibility with the reactor coolant, cost, and the nuclear and physical properties of the material. Consideration of each material application in terms of operating stress, temperature, and total expected neutron fluence is discussed. Components of Zr, austenitic stainless steel, Ni-base, and low alloy pressure vessel alloys for water reactor systems are considered. (J.C.W.)

38443 (CEA-R-3180) SPECTRE DES NEUTRONS RAPIDES DANS LE REFLECTEUR D'UNE PILE A EAU LEGERE. (Fast Neutron Spectrum in the Reflector of a Swimming-Pool Type Reactor). Mas, Pierre; Lloret, Raoul; Comera, Jean (Commis-

sariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). June 1967. 20p. (In French). Dep.

The results of spectrum index measurements in the Melusine and Triton reflectors are given. These indexes are defined as the activities induced by $^{115}In(n,n')$, $^{58}Ni(n,p)$, $^{27}Al(n,\alpha)$ reactions. These ratios are normalized in the core centre where a fission spectrum for the fast neutrons (above 1 MeV) is assumed. The fast neutron spectrum is written in the form proposed by M. Genthon. (auth)

38444 (CONF-670214-1) NUCLEAR POWER: A STATUS REPORT. Erb, Donald E. (Division of Reactor Development and Technology (AEC), Washington, D. C. Water Projects Branch). Feb. 9, 1967. 12p. Dep. CFSTI.

From 11th Annual American Public Power Association Engineering and Operations Conference, San Antonio, Tex.

An overall survey of the use of nuclear power plants for generating electricity is presented. The magnitude of current investment and the prediction of future economics are discussed. Required reliability and the establishment of commercial credibility of advanced reactor concepts are discussed. (M.L.S.)

38445 (CVNA-286) ANALYSIS OF CVTR THERMAL-HYDRAULIC PERFORMANCE AT 65-MW OPERATION. Sandberg, R. O. (Westinghouse Electric Corp., Pittsburgh, Pa. Advanced Reactors Div.). June 1967. Contract AT(30-1)-2289. 75p. Dep. CFSTI.

The thermal-hydraulic performance of the CVTR reactor core after a thermal power increase from 44.3 MW (fission) to 65.0 MW(fission) is presented. The data on the high power test assemblies installed during the power level change are also presented. (D.C.C.)

38446 (DOCKET-50-263(Amend.5)) MONTICELLO NUCLEAR GENERATING PLANT, MONTICELLO, MINNESOTA, UNIT 1. AMENDMENT 5, OPERATING EXPERIENCE WITH FIELD ASSEMBLED PRESSURE VESSELS. (Northern States Power Co., Minneapolis, Minn.). [nd]. 9p. Dep. CFSTI.

A brief history and evaluation of the operating experiences of approximately 200 vessels which were field assembled by the Chicago Bridge and Iron Company are presented. A more comprehensive review was made for 9 of these vessels which are more directly applicable to the size, pressure and temperature conditions of the Monticello vessel. The information presented is considered typical and representative of applicable operating experience to date. The many vessels investigated were found to be performing to their service conditions in a completely satisfactory manner and without failure. The only apparent vendor of heavy-wall field assembled pressure vessels in the United States is the Chicago Bridge and Iron Company so that this survey represents U. S. experience in this field. (auth)

38447 (GA-6830) PUBLIC SERVICE COMPANY OF COLORADO 330-MW(E) HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending September 30, 1965. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Dec. 31, 1965. Contract AT(04-3)-633. 156p. Dep. CFSTI.

PRESSURE VESSELS—design for Fort St. Vrain Reactor prestressed concrete
FORT ST. VRAIN POWER REACTOR—coolant for, compatibility of metals with impure
VALVES—design of steam/water dump, for Fort St. Vrain Reactor
INSTRUMENTS—moisture detector design for Fort St. Vrain Reactor
FORT ST. VRAIN POWER REACTOR—remote handling tools and manipulators for, use of
REACTOR FUELS—fuel cycle economics for Fort St. Vrain Power Reactor
REACTOR FUEL ELEMENTS—burnup in Fort St. Vrain
NEUTRONS—balance in equilibrium cycle of Fort St. Vrain Reactor
FORT ST. VRAIN POWER REACTOR—physics parameters for, tabulation of calculated; fuel loading for, initial
REACTOR FUELS—zoning in Fort St. Vrain, effects on power distribution of
REACTOR FUEL ELEMENTS—design of Fort St. Vrain
HEAT TRANSFER—analysis of hottest cylindrical fuel element in Fort St. Vrain Power Reactor
FORT ST. VRAIN POWER REACTOR—fuel elements for, heat transfer analysis of hottest cylindrical
GRAPHITE—deformation in, analysis of radioinduced
FISSION PRODUCTS—transport in steam-helium mixture; release from PYC-coated thorium-uranium carbide fuel particles; release from high-temperature gas-cooled fuels of metallic; release constants for high-temperature gas-cooled reactor fuels
FORT ST. VRAIN POWER REACTOR—core for, packing studies on pebble bed
GRAPHITE—mechanical properties of, testing of
REACTOR FUEL ELEMENTS—radiation testing of coated particle-type
COMPUTER PROGRAMS—FREVAP, for estimating long-lived metallic fission products from high-temperature gas-cooled reactor fuels
CESIUM—deposition on Type 304 stainless steel
STRONTIUM—deposition on Type 304 stainless steel
HELIUM—cleaning system for, description of
DECONTAMINATION—testing of stainless and copper for
REACTOR LOADING MACHINES—design for Fort St. Vrain Reactor
COMPRESSORS—design for Fort St. Vrain Reactor, aerodynamic and mechanical
TURBINES—design parameters for Fort St. Vrain Reactor
REACTOR CONTROL ELEMENTS—drives for Fort St. Vrain Reactor, design of
BOILERS—stability of Fort St. Vrain Reactor, steam/water flow; design analysis of Fort St. Vrain Reactor
REACTOR FUELS—coatings for, development of buffer
COATINGS—development of fuel particle buffer (M.L.S.)

38448 (GA-6836) ABE-SRC-1: AN INTERNALLY-COOLED HIGH CONVERSION RATIO ADVANCED BERYLLIA FUEL ELEMENT. Trickett, K. A.; Malek, G. J.; McWhirter, A. D. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Apr. 1, 1966. Contract AT(04-3)-187. 34p. Dep. CFSTI.

The development of a high-conversion-ratio beryllia fuel element is detailed. Methods of fabrication of spherical elements for advanced reactors are discussed. Design data are presented. Fuel cladding effects are detailed. (M.L.S.)

38449 (GA-6950) PUBLIC SERVICE COMPANY OF COLORADO 330-MW(E) HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending December 31, 1965. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Mar. 21, 1966. Contract AT(04-3)-633. 109p. Dep. CFSTI.

Research and development work on the 330 MW(e) high-temperature gas-cooled reactor (Fort St. Vrain) is presented. This includes Component Development: reactor vessel–PCRV model tests; reactor thermal barrier–Class A thermal barrier, metal–impure coolant compatibility test, and nonmetallic structural materials; primary coolant system flow; compressors and auxiliary circulators–compressors, auxiliary circulators; valves-steam-water dump valve, He source valves; instrumentation and electrical–moisture detectors, electrical penetrations. The section on Nuclear Analysis includes: fuel cycle analysis–over-all core dimensions and maximum fuel burnup; fuel zoning and power distribution; kinetic analysis; analytical studies–criticality safety of fuel transfer machine. Fuel Development consists of: design–mechanical design, thermal design, fission-product transport; materials–particle beds, bonded particle systems, graphite development, control materials; chemistry–fission-product release, sorption and diffusion products. Work on the Fuel Transfer Machine is outlined. The Series Steam-Turbine-Driven Circulator section includes: helium circulator development; rotor dynamic simulation and lubrication and seal system test; static aerodynamic components, prototype test facility. Control Rod Drive examination is outlined. The section on Steam Generators contains: materials; heat transfer and fluid flow–steam/water flow stability, tube vibration studies; design and analysis; steam generator tube plugging machine. Coated Particle Development includes: buffer coating studies–deposition studies, diffusivity measurements; high-density isotropic coatings; coated particle preparation–Dounreay Fast Reactor irradiation, capsule P14, ORNL radiations, capsule G11; coating evaluation techniques–x-ray absorption density determination, electron microscope density determination, particle geometry (T/D) studies; thermal stability studies–fission-product release. (M.L.S.)

38450 (GA-7181) HTGR BASE PROGRAM QUARTERLY PROGRESS REPORT FOR THE PERIOD ENDING MAY 31, 1966. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). June 30, 1966. Contract AT(04-3)-167. 38p. Dep. CFSTI.

Developments concerning the prestressed concrete reactor vessel for the high-temperature gas-cooled reactor are discussed. Operational data for the General Atomic In-Pile Loop (GAIL) are tabulated. Diffusion studies on the high-temperature gas-cooled reactor coolant are detailed. Fission product deposition from high-temperature gas-cooled reactor coolant on plateout sleeves was

measured in GAIL; an analysis of particulate matter in GAIL is presented. Analyses of GAIL membrane filters are given; activity scans of GAIL main loop filters are discussed. Details of space-dependent kinetics calculations for the high-temperature gas-cooled reactor are presented. Fuel processing and shipping costs are given for two sizes of reactors with unbonded fuel particles. An evaluation of advanced types of coated particles under potential high-temperature gas-cooled reactor irradiation environment is presented; results are detailed. (M.L.S.)

38451 (GA-7314) PUBLIC SERVICE COMPANY OF COLORADO 330-MW(e) HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending June 30, 1966. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Sept. 30, 1966. Contract AT(04-3)-633. 134p. Dep. CFSTI.

Studies for the Fort St. Vrain Power Reactor are detailed. Component development includes Reactor Vessels—PCRV (prestressed concrete pressure vessel) No. 2 testing, PCRV No. 2 design and analysis, PCRV liner, prestressing system, penetration closures, and concrete properties; Thermal Barrier; Primary Coolant System Flow; Compressors; Valves—steam/water dump valves, and He service valves; Instrumentation and Electrical—moisture detectors and electrical penetrations; and Auxiliary Equipment and Special Tools. Nuclear Analysis includes Fuel Cycle Analysis—maximum fuel burnup; Power Shaping—maximum region peaking and power distribution in rodded configurations; and Kinetic Analysis—control system and transient analysis of rod withdrawal accidents. Fuel development includes Fuel Element Design—mechanical design, thermal design, and fission-product transport; Materials—particle fuel systems and irradiation testing; Chemistry—fission-product release, and sorption and diffusion of fission products; Helium Purification System; Sorbent Beds—low-temperature adsorption studies, high-temperature adsorption studies, helium purification system components, carbon transport and deposition. Fuel transfer machine design and testing is discussed. The design for the series-steam-turbine-driven circulator is detailed. Control-rod drive testing is outlined. The steam generator tube vibration testing and steam/water flow stability testing is presented. Coated particle development includes buffer coating studies; Coated Particle Preparation—capsule P15 and petten irradiations; Coating Evaluation Techniques—particle geometry studies, coating contamination studies, and coating density measurements; Thermal Stability Studies; and Fission-Product Release. (M.L.S.)

38452 (GA-8025) PHYSICS TESTS DURING THE INITIAL OPERATION OF THE PEACH BOTTOM HTGR. Brown, J. R.; Hopkins, G. R.; Van Howe, K. R. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). June 5, 1967. Contract AT(04-3)-314. 26p. (CONF-670602-23). Dep. CFSTI.

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif.

The Peach Bottom High-Temperature Gas-Cooled Reactor (HTGR) is now operating at design conditions of 115 megawatts thermal power, 40 megawatts net electrical output and 1000°F, 1450 psi steam conditions. During the rise to full power, data were obtained for physics tests to verify the design performance of the reactor core. These tests included measurements of fuel temperature, core reactivity changes, temperature coefficient of reactivity, control rod calibration, heat transfer film coefficient and frequency response of neutron noise. (auth)

38453 (GAMD-7656) FREVAP-6 CODE FOR ESTIMATING METALLIC FISSION PRODUCT RELEASE. Zumwalt, L. R.; Pierce, V. H.; Gerber, M. J. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Jan. 12, 1967. Contract AT(04-3)-633. 72p. DTIE.

A computer code, FREVAP, for estimation of release of long-lived metallic fission products from fuel particles is given. It takes into account the rather strong sorption of the fission products by graphite. The basic inputs are the empirical release constants and sorption data. The program is written in FORTRAN IV, and is presented in detail. (M.L.S.)

38454 (GAMD-7867) DEVELOPMENTAL COMPONENTS FOR THE ADVANCED CONVERTER EVALUATION: REFERENCE DESIGN. Jaye, S.; Morse, D.; Bell, F.; Donelson, S. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Mar. 9, 1967. Contract AT(04-3)-167. 19p. Dep. CFSTI.

An evaluation of advanced converter reactors is given. A comparison of two approaches to a scale-up to 1000 MWe of the Fort St. Vrain Nuclear Generation Station is presented. The steam cycle, PCRV (prestressed concrete reactor vessel), steam generators, and refueling machine are discussed in detail. The steam generator design parameters for both designs (radial flow and axial flow) are tabulated. (M.L.S.)

38455 (GEAP-5473) DEVELOPMENT PROGRAM ON THE GARIGLIANO NUCLEAR REACTOR. Quarterly Report No. 18. Howard, C. L. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Apr. 1967. Contract AT(04-3)-189. 100p. (EURAEC-1875). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The experimental data obtained during stability tests at the Garigliano Nuclear Reactor have been compared with two analytical models. The FABLE model is a multinode and multichannel model which calculates the coupled nuclear-hydrodynamic response of boiling water reactors. The STA model is a single-node and single-channel model which also computes the coupled nuclear-hydrodynamic response of BWR's. Comparisons of the analytic stability gain and phase margins and the closed loop peak magnitude with the experimental data show that the FABLE model predicts these measures of stability performance slightly better than the STA model. A mass flux effect exists in the data which results in both the STA and FABLE models giving more conservative predictions of the measures of stability at low than at high mass fluxes. (auth)

38456 (GEAP-5474) REACTOR PRIMARY COOLANT SYSTEM RUPTURE STUDY. Quarterly Progress Report No. 8, January-March 1967. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). May 1967. Contract AT(04-3)-189. 95p. Dep. CFSTI.

Relationships for the low-cycle fatigue mechanism of failure were developed. Additional uncertainty distributions were devised. Computer code PAPA development for the elastic analysis of piping components was completed. All portions of the code were written, checked out, and used to analyze structures of intermediate complexity such as the flat plate with hole and shallow cone (GEAP-5427). Problem solutions effort centered in two areas: the development of preprocessor computer codes to use with PAPA and the completion of stress calculations for a typical BWR piping system. A preprocessor for an elbow was completed, and a piping tee preprocessor is in the final stages of checkout. In the experimental stress work, which is designed to provide verification of PAPA results, photoelasticity models and birefringent photoelastic coatings on metal models are being studied. The initial specimens were tested and results are being analyzed. Six burst tests at room temperature on flawed carbon steel pipe up to 6 inches in diameter were conducted in addition to two tests on unflawed pipe. Yield and burst pressures and circumferential strains were measured. Through-wall and part-through-wall machined "cracks" in longitudinal and transverse directions are included in the series. These tests, using hydraulic pressurization, showed net section breaking stresses within 10% of the ultimate strength of the material. Fractographic work conducted to correlate the features of fracture surfaces with K_{Ic} measurement is reported. For the limited data available, it was shown that there is a direct relation between the stretched zone at a fatigue crack tip and K_{Ic}. In contrast to the reduced crack growth rate data reported previously, more recent measurements at higher stresses revealed no significant rate change at 600°F for carbon steel when a slower cycling rate or hold times were imposed. The rate of growth of part-through cracks in low carbon steel plates was measured for comparison with through-wall crack growth. Good agreement was obtained between predicted and observed crack growth. The first crack growth tests of pipe half sections (material from the prototype piping at Vallecitos) demonstrated the practicability of the newly devised test method. In crack initiation studies at 550°F, the three piping materials were tested using edge-notched plate specimens with $K_t = 3$. In comparison with results at room temperature, 2-1/4 Cr-1 Mo steel showed no appreciable effect but the carbon steel and stainless steel behaved differently. In both, flatter curves were evident—cracking and failure occurred at fewer cycles above a certain stress, but endured for more cycles below that stress. The first three prototype pipe fatigue tests were made on plain carbon steel, A-106B, straight pipe specimens. In the first two the crack initiated at the notch, then, after wall penetration, grew around the pipe. The test was terminated with about 2 inches of material remaining. In the third test, the cycling was terminated as soon as wall penetration occurred in order to conduct fractographic examination. Ultrasonic measurements of crack growth through the wall indicated a constant rate, which is not in accord with theory or the observations made in Subtask, D-1. The fractographic method of measuring the fatigue striations with an electron microscope will be used to measure the growth rate. A boot patch technique was devised for providing an internal seal for the crack so that pressure (1000 psi) can be maintained while crack growth continues circumferentially around the pipe wall. (auth)

38457 (GEAP-5491) SODIUM-COOLED REACTORS FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Quarterly

Report No. 22, February–April 1967. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). May 1967. Contract AT(04-3)-189. 102p. Dep. CFSTI.

Sodium-cooled fast ceramic reactor development is presented. Results of irradiation of mixed oxide capsules is tabulated. The irradiation program in EBR-II for both fuels and capsule materials is presented in tabular form. The development of fuels under conditions of venting, defecting, and Na-bonding is discussed. Fuel and cladding behavior under various accident conditions is detailed. Fuel materials and performance evaluation is presented; and isotopic distribution of γ energy is given for one fuel capsule. The effects of medium power, long term irradiation on fuel pins is tabulated. An evaluation of nuclear data and group constants is outlined; models for core neutronic analysis are discussed; space-dependent kinetics for transient and safety analyses are tabulated; a thermal hydraulic analysis of the core is given. Cladding development, considering radiation damage and coolant compatibility, is detailed. 26 references. (M.L.S.)

38458 (KAPL–3160) REACTOR KINETICS MODEL: TWO MODES, WITH SUGGESTED TEST FOR DETERMINING THE REACTIVITY COUPLING COEFFICIENT. Pendergast, M. S. Jr. (Knolls Atomic Power Lab., Schenectady, N. Y.). Sept. 1966. Contract W-31-109-eng-52. 70p. Dep. CFSTI.

When one-mode reactor kinetics are used to obtain the transient behavior of the reactor power, the spatial shape of the power density is assumed to be fixed at all times with the amplitude being given by the one-mode reactor kinetics equations. With two-mode reactor kinetics, the spatial shape of the power density is assumed to be a linear combination of a symmetric mode and a tilt mode with time-varying coefficients given by the two-mode reactor kinetics equations. In order to effect a time solution of the two-mode reactor kinetics equations, information must be available beyond that necessary for a one-mode reactor kinetics equations solutions. In particular, the separation of eigenvalues (of the symmetric and tilt modes) must be known. This quantity is sometimes termed the reactivity coupling coefficient ($\delta_t k_o$). A test for the determination of $\delta_t k_o$ is suggested. The suggested test is devised by casting the two-mode reactor kinetics equations in the form of transfer functions that are suitable for small variations about a steady-state operating point, and by obtaining transfer functions for the ion chambers from which the reactor is observable. The existence of a left, a right, and a central ion chamber is assumed. Basically, the test consists of oscillating the tilt mode at two different frequencies, while holding the symmetric mode nearly stationary. (auth)

38459 (KAPL-M-6714) A NOTE ON THE SHAPE OF THE FISSION PEAK IN HYDROGEN MODERATED REACTORS. Reiter, R. A. (Knolls Atomic Power Lab., Schenectady, N. Y.). May 1967. Contract W-31-109-eng-52. 9p. Dep. CFSTI.

Simple calculations have been performed to demonstrate the effects of some physical parameters on the shape of the "fission peak" in the neutron spectrum. The shape of the high energy side of the peak is found to depend strongly on the fission spectrum and on inelastic scattering while the low energy side depends almost entirely on the hydrogen scattering cross section. (auth)

38460 (NAA-SR-Memo-12340(Rev.)) HALLAM NUCLEAR POWER FACILITY RETIREMENT PLAN. (Atomics International, Canoga Park, Calif.). Feb. 24, 1967. Contract AT(04-3)-701. 42p. Dep. CFSTI.

The analysis of the plan to decontaminate and decommission the Hallam Nuclear Power Facility is given. (J.C.W.)

38461 (NASA-TN-D-4093) CONTROL OF A NUCLEAR REACTOR WITH A GASEOUS CONTROL SYSTEM. Davison, Harry W.; Heath, Colin A.; Lowen, Walter (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Aug. 1967. 68p. CFSTI.

A control system concept utilizing a neutron-absorbing gas, ^3He was investigated for use with a water-moderated reactor. A static gas system is finely distributed throughout the reactor core to minimize flux depression effects by the control medium. Reactivity control is performed by controlled pressurization of the He gas. Investigations have been performed in the areas of ^3He containment and thermal and neutronic stability during operation. Although there is some probability that leaks could occur in the control system, the rate of loss of He can be limited such that the reactor can be shutdown before it is damaged. Potential accident situations are limited by using flow restricting orifices in the system and by providing a positive water pressure seal on the control system. The possibility of positive power coefficients of reactivity with a gaseous poison system was examined. Power coefficients of reactivity can be made small, and in some cases negative, by careful design. Configurations of a control element with small temperature and density gradients and a distribution system that provides a negative power coefficient are presented. The concept of reactor control with ^3He in metal control elements located in the moderator region appears feasible for the system investigated. (auth)

38462 (ORNL–3981) OUT-OF-PILE STUDIES OF FISSION-PRODUCT RELEASE FROM OVERHEATED REACTOR FUELS AT ORNL, 1955–1965. Parker, G. W.; Creek, G. E.; Barton, C. J.; Martin, W. J.; Lorenz, R. A. (Oak Ridge National Lab., Tenn.). July 1967. Contract W-7405-eng-26. 121p. Dep. CFSTI.

Studies of fission product release from overheated reactor fuel materials at ORNL to supply data needed to determine the hazard of nuclear reactor accidents are presented. A discussion of factors affecting fission product release, a description of techniques, a compilation of data obtained, some illustrations of the use of the data, and some recommendations for further research are included. (auth)

38463 (ORNL–4133) GAS-COOLED REACTOR PROGRAM SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING MARCH 31, 1967. Savolainen, Ann W. (Oak Ridge National Lab., Tenn.). Aug. 1967. Contract W-7405-eng-26. 200p. Dep. CFSTI.

Developments of various aspects of gas cooled reactors are presented. These aspects include: fuel element development—mechanisms and kinetics of the conversion of UO_2 to UC, deposition and characterization of silicon carbide coatings, and bonding of coated fuel particles for fuel elements; irradiation tests of high-temperature gas-cooled reactor fuel and fuel elements—preparation and evaluation of coated UO_2, UC_2 and $(Th,U)O_2$ fuel particles for irradiation tests, sweep-capsule coated-particle irradiation tests, irradiation tests in GCR-ORR Loop 1, irradiation tests in the LITR, high-burnup coated-particle irradiation, new irradiation experiment designs; studies of graphite and pyrolytic-carbon properties and irradiation effects—preparation and characterization of specimens for the ORNL-DFR-2, -3, and -4 irradiation experiments, results of fast neutron irradiation of pyrolytic carbons in the ORR; mathematical analysis of fuel element behavior; fission product release and transport studies—fission product release from high-burnup coated fuel particles by post-irradiation annealing and fission product transport and deposition; oxidation studies of coated particles, graphite, and fuel element segments—compatibility of pyrolytic-carbon-coated fuel particles with water vapor, reaction of graphite with steam, and reaction of bonded fuel element segments with steam; nuclear safety program studies—engineering-scale steam-graphite reaction rate experiment, in-pile studies of reactions of fueled graphite and the behavior of fission products under high-temperature gas-cooled reactor accident conditions, and irradiation tests in the ORR Poolside Facility for measuring fission-product release; high-temperature gas-cooled reactor analysis; prestressed concrete reactor pressure vessel development—program developments, biaxial creep studies, and model study of prestressed-concrete reactor pressure vessels; component development; irradiation tests of gas-cooled fast reactor fuel, fuel elements, and heat transfer studies—capsule irradiations to study interactions of fuel and cladding, irradiation tests in helium-cooled ORR Loop 1, gas-cooled fast reactor (GCFR) vented fuel element design, gas transport in vented fuel elements, and heat-transfer enhancement with gaseous flows; modification of gas-cooled reactor-ORR Loop 1 for operation with higher coolant pressure. (M.L.S.)

38464 (ORNL-NSIC–35) NSIC KEYWORD THESAURUS. (Oak Ridge National Lab., Tenn.). Aug. 1967. Contract W-7405-eng-26. 71p. Dep. CFSTI.

A thesaurus of terms used by the Nuclear Safety Information Center for retrieval of reactor safety information is given. (M.L.S.)

38465 (PRWRA–111) BONUS PLANT CONVENTIONAL CYCLE HEAT BALANCE. Velez, Gilberto A.; Bonnet, Juan A. Jr. (Puerto Rico Water Resources Authority, Rincon, BONUS Nuclear Power Station). May 1967. 30p. (WRA-B-67-12). Dep. CFSTI.

Calibration checks on BONUS plant instrumentation were made. A measurement of the overall heat transfer coefficient was made and compared to the design value. Heat transfer measurements were made to determine the heat balance for the four feedwater heaters at full capacity. Cycle efficiencies for the BONUS superheater boiling reactor and standard BWRs and PWRs are compared. An economic discussion of this point is given. (M.L.S.)

38466 (RT/ING–(67)2) THERMODYNAMICS OF LIQUID DIABATIC FLOW AND RELATED INSTABILITIES. Basso, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1967. 67p. Dep.

Problems regarding thermal and/or hydraulic instabilities, arising under severe operating conditions in nuclear reactor cores,

cooled by non-saturated liquids, require being correctly solved and interpreted on the basis of thermodynamic theory, extended to visco-elastic fluids. The limiting conditions for stability in a non-adiabatic flow shows, inter alia, that burnout is associated with the onset and propagation of shock waves. In this context theoretical equations are derived for the critical heat flux which are in good agreement with predictions made when using empirical correlations. (auth)

38467 (TID-8200(16th Rev.)) NUCLEAR REACTORS BUILT, BEING BUILT, OR PLANNED IN THE UNITED STATES AS OF JUNE 30, 1967. (Office of the Assistant General Manager for Reactors (AEC), Washington, D. C.). 33p. Dep. CFSTI.

A compilation is presented on information on power, testing, research, propulsion, safety-experiment, and teaching reactors and critical facilities in the U. S. as of June 30, 1967. The information is categorized by primary function on purpose of the reactor or facility. (D.C.C.)

38468 (TID-23910) 237 MW KRB NUCLEAR POWER PLANT. Quarterly Report No. 15, September 30–November 1, 1966. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany)). 53p. Dep. CFSTI.

A permit was granted for carrying out a hydrostatic test and control rod trials. The subsequent hydrostatic test revealed leakages in the control rod drive flanges. The elimination of these leakages was completed. The installation of the support structure has been completed. Operation of the installation was begun and power tests commenced. The plant was connected to the grid for the first time at 1653 hrs on November 12, 1966. It remained in operation until January 4, 1967 so that power tests could be carried out. By December 31, 1966 the plant had produced 93 GWh. (J.C.W.)

38469 (TID-23919) PLANT OPERATING EXPERIENCE, PATHFINDER TESTING RESULTS 40 TO 85 PERCENT POWER. Six-Month Operating Report No. 2, November 19, 1966–May 19, 1967. (Northern States Power Co., [Sioux Falls, S. Dak.]). June 15, 1967. Contract AT(11-1)-589. 156p. (NSP-6701). Dep. CFSTI.

SIOUX FALLS POWER REACTOR—operation history of; control of, summary of techniques for; coolant recirculation flow in, noise effects caused by; control rod motion in, system response to variations in; safety instrumentation for

REACTOR FUEL ELEMENTS—performance of Sioux Falls Power Reactor superheater

REACTIVITY—measurements in Sioux Falls Power Reactor

TURBINES—testing of Sioux Falls Power Reactor, load dump

BOILERS—void levels for Sioux Falls Power Reactor

RADIATION MONITORING—results of Sioux Falls Power Reactor survey

THERMOCOUPLES—use for measurement of shutdown superheater fuel temperature

REACTOR SAFETY—boron-injection system for Sioux Falls Power Reactor; turbine dump valve failure in Sioux Falls Power Reactor (M.L.S.)

38470 (TID-23922) GARIGLIANO NUCLEAR POWER PLANT. Operation Report for the 1st Quarter of 1967. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). Mar. 31, 1967. 16p. Dep. CFSTI.

Operating statistics for the period from January 1 to March 31, 1967 are presented for the Garigliano nuclear power plant. Daily power curves, fuel burnup, distribution, and health physics data are also presented. (D.C.C.)

38471 (TID-23940) ML-1 5 PERCENT BORIC ACID SHIELD SOLUTION EXPERIMENT. Test Report. Rogers, D. R. (Aerojet-General Nucleonics, San Ramon, Calif.). Oct. 5, 1965. 29p. (AN-AGCR-936; EAD-314). Dep. CFSTI.

The experimental results of the addition of 5 wt % boric acid to the water shielding of the ML-1 reactor are presented. Results show that dose rates with 5 wt % solution were about 20% higher than dose rates reported for 10 wt % solution, that no correlation between fast neutron dose rate and boric acid concentration exists, and that previous predictions of the effect of boric acid concentration on both the total shutdown gamma dose rate and that portion of the total dose rate due to stainless steel activation have been overestimated. (D.C.C.)

38472 (WAPD-TM-680) A DIGITAL COMPUTER PROGRAM FOR NUCLEAR REACTOR DESIGN WATER PROPERTIES. Lynn, LeRoy L. (Bettis Atomic Power Lab., Pittsburgh, Pa.). July 1967. Contract AT(11-1)-Gen-14. 35p. Dep. CFSTI.

An edit program MO899 for the tabulation of thermodynamic and transport properties of liquid and vapor water, frequently used in design calculations for pressurized water nuclear reactors, is described. The data tabulated are obtained from a FORTRAN IV subroutine named HOH. Values of enthalpy, specific volume, viscosity, and thermal conductivity are given for the following ranges: pressure from one bar (14.5 psia) to 175 bars (2538 psia) and temperature from as much as 320 deg C (608 deg F) below saturation up to 500 deg C (932 deg F) above saturation. (auth)

38473 (WAPD-TM-681) CANONICAL FORMULATIONS OF THE ELASTICITY PROBLEM AND THE APPLICATION TO DERIVING DIFFERENCE EQUATIONS. Kaplan, S. (Bettis Atomic Power Lab., Pittsburgh, Pa.). May 1967. Contract AT(11-1)-Gen-14. 26p. Dep. CFSTI.

The minimum potential energy variational principle of elasticity theory is transformed into its canonical (Reissner's) and involutory (Castigliano's) forms. The canonical form is extended to include discontinuous functions in its domain of admissible functions. This extended principle is used to derive finite difference equations for the plane strain problem using interlacing step functions as the trial functions. (auth)

38474 (WAPD-TM-695) NATURAL MODES OF THE XENON PROBLEM WITH TEMPERATURE AND CONTROL FEEDBACK. Kaplan, S. (Bettis Atomic Power Lab., Pittsburgh, Pa.). May 1967. Contract AT(11-1)-Gen-14. 14p. Dep. CFSTI.

The p-mode formalism, which identifies the natural motions and time constants of a reactor in the presence of xenon feedback, is extended to the case where temperature and control feedbacks are also present. Two methods are discussed by which these modes might be numerically computed. (auth)

38475 (WCAP-3677-4) FRACTURE MECHANICS EVALUATION OF REACTOR VESSEL STEELS. Quarterly Progress Report for the Period Ending June 30, 1967. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). July 1967. Contract AT(30-1)-3677. 22p. (EURAEC-1879). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

An evaluation of the fracture mechanics approach to analysis of brittle fracture of reactor vessel materials is given. An irradiation facility, to be used for testing reactor vessel steel samples, is described. Tensile properties of some of the materials are listed. (M.L.S.)

38476 PERFORMANCE OF VIBRATORILY COMPACTED MIXED-OXIDE FUEL RODS UNDER FAST-REACTOR CONDITIONS. Brown, F. L.; Neimark, L. A.; Koprowski, B. J.; Ayer, J. E.; Kittel, J. H. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 101-2(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38477 RESIDUAL FUEL CONTENT OF SHIPPINGPORT CORE 1 SEED FUEL: CALCULATION VS EXPERIMENT. Crawford, J. A. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 10: 302-3(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38478 INTEGRAL TRANSPORT METHOD FOR BURNUP IN HETEROGENEOUS ASSEMBLIES. Noderer, L. C.; O'Shea, D. M. (Combustion Engineering, Inc., Windsor, Conn.). Trans. Amer. Nucl. Soc., 10: 303-4(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38479 ADEQUACY OF A CALCULATION METHOD FOR REACTIVITY ASSESSMENTS IN LIGHT-WATER REACTORS. Ariemma, A.; La Parola, G. Lesnoni; Paoletti Gualandi, M. (ENEL-DCTN, Rome). Trans. Amer. Nucl. Soc., 10: 304-5 (June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38480 EVALUATION OF SOME NUCLEAR CALCULATIONAL METHODS FOR USE IN PLUTONIUM RECYCLE. Celnik, J.; Kellman, S. (United Nuclear Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc., 10: 305-6(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38481 ANALYSIS OF PuO_2–UO_2 CRITICAL EXPERIMENTS. Eich, W. J. (Westinghouse Electric Co., Pittsburgh). Trans. Amer. Nucl. Soc., 10: 306-7(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38482 FRENCH NATURAL-URANIUM GRAPHITE-MODERATED GAS-COOLED NUCLEAR POWER STATIONS. Bienvenu, C.; Saitcevsky, B. (Electricite de France, Lyon). Trans. Amer. Nucl. Soc., 10: 315(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38483 DESIGN DEVELOPMENT OF BRITISH GAS-COOLED REACTORS. Wolff, P. H. W. (Nuclear Design and Construction Ltd., Whetstone, Eng.). Trans. Amer. Nucl. Soc., 10: 315 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38484 THE GAS-COOLED REACTOR. Brown, G. (Atomic Power Constructions Ltd., Sutton, Eng.); Thorn, J. D. Trans. Amer. Nucl. Soc., 10: 315-16 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38485 FRENCH PROGRAM ON HEAVY-WATER GAS-COOLED REACTORS. Fonteray, P. J. (Commissariat a l'Energie Atomique, Paris). Trans. Amer. Nucl. Soc., 10: 316-17 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38486 IRRADIATION TESTING OF CANDIDATE FUEL RODS FOR THE GCFR. Siltanen, J. N. (General Atomic Div., General Dynamics Corp., San Diego, Calif.); McQuilkin, F. R.; Long, E. L. Jr.; Lindgren, J. R. Trans. Amer. Nucl. Soc., 10: 104-5 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38487 PERFORMANCE OF ADVANCED U–Pu–Zr ALLOY FUEL ELEMENTS UNDER FAST-REACTOR CONDITIONS. Beck, W. N.; Brown, F. L.; Koprowski, B. J.; Kittel, J. H. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 106-7 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38488 COMPATIBILITY OF STABILIZED HYPOSTOICHIOMETRIC URANIUM–PLUTONIUM–MONOCARBIDE FUELS WITH STAINLESS STEEL. Jacoby, W. R. (Westinghouse Electric Corp., Cheswick, Pa.); Palm, R. G.; Latimer, T. W. Trans. Amer. Nucl. Soc., 10: 108-10 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38489 DESIGN CONSIDERATIONS FOR SODIUM-BONDED URANIUM–PLUTONIUM–CARBIDE FUEL FOR LARGE FAST-BREEDER REACTOR APPLICATION. Cherry, B. H.; Rutland, L. (United Nuclear Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc., 10: 110-11 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38490 ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF THREE-DIMENSIONAL FLOW DISTRIBUTION IN A GAS-COOLED REACTOR. Malek, G. J. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 350-1 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38491 EFFECT OF FUEL-PIN ROUGHNESS AND PARTIAL ROUGHNESS ON FAST GAS-COOLED REACTOR PERFORMANCE. Wichner, R. P. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 350 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38492 ANALYTICAL INVESTIGATION OF THE EFFECT OF VARIABLE WALL HEAT FLUX ON TURBULENT LIQUID METAL HEAT-TRANSFER COEFFICIENTS IN REACTOR COOLANT CHANNELS. Johannsen, Klaus (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 10: 352-3 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38493 THEORETICAL STUDIES OF THE TRANSIENT BOILING OF SODIUM IN FAST-REACTOR COOLANT CHANNELS. MacFarlane, D. R. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 354 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38494 TRANSIENT VOID AT HIGH PRESSURE. Schrock, V. E.; Johnson, H. A. (Univ. of California, Berkeley). Trans. Amer. Nucl. Soc., 10: 359 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38495 SUBATMOSPHERIC CONTAINMENT. Noble, John H. (Stone and Webster Engineering Corp., Boston). Trans. Amer. Nucl. Soc., 10: 329-30 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38496 NONDESTRUCTIVE FLAW DETECTION IN NUCLEAR POWER INSTALLATIONS. Parry, D. L. (Phillips Petroleum Co., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 10: 330-1 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38497 CHEMICAL BEHAVIOR IN THE MOLTEN-SALT REACTOR EXPERIMENT. Thoma, R. E.; Grimes, W. R.; Blankenship, F. F. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 155 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38498 USE OF QUASILINEARIZATION FOR THE IDENTIFICATION OF NUCLEAR REACTOR PARAMETERS. Habegger, L. J.; Bailey, R. E.; Kadavanich, K. (Purdue Univ., Lafayette, Ind.). Trans. Amer. Nucl. Soc., 10: 176-7 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38499 LOCAL BOILING VOID FOR CALCULATING MODERATOR COEFFICIENT. Tong, L. S. (Westinghouse Electric Co., Pittsburgh). Trans. Amer. Nucl. Soc., 10: 357 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38500 GENERATION AND RELEASE OF TRITIUM IN PM-TYPE NUCLEAR POWER PLANTS. Ray, Joseph W. (Battelle Memorial Inst., Columbus, Ohio). Trans. Amer. Nucl. Soc., 10: 324-5 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38501 PRESSURIZER PERFORMANCE DURING LOAD DROP TESTS AT SHIPPINGPORT: ANALYSIS AND TEST. Redfield, J. A. (Bettis Atomic Power Lab., West Mifflin, Pa.); Prescop, V.; Margolis, S. G. Trans. Amer. Nucl. Soc., 10: 323 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38502 330 MW(e) FORT SAINT VRAIN HIGH-TEMPERATURE GAS-COOLED REACTOR. Habush, A. L.; Harris, A. M. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 320-1 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38503 ENGINEERING TESTS DURING THE INITIAL OPERATION OF THE PEACH BOTTOM HTGR. Kantor, M. E.; Menzel, H. F.; Schlicht, R. W.; Westlake, W. J. Jr. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 319-20 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38504 PHYSICS TESTS DURING THE INITIAL OPERATION OF THE PEACH BOTTOM HTGR. Brown, J. R.; Hopkins, G. R.; Van Howe, K. R. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 319 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38505 HIGH-TEMPERATURE POWER REACTORS. Rennie, C. A. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). Trans. Amer. Nucl. Soc., 10: 319 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38506 GAS-COOLED FAST-REACTOR CONCEPT EVOLUTION OF A 1000-MW(e) REFERENCE DESIGN. Fortescue, Peter (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 317 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38507 BURST AND TENSILE PROPERTIES OF IRRADIATED INCOLOY-800 AND INCONEL-625 TUBING MATERIALS. Ogawa, S. Y. (General Electric Co., San Jose, Calif.); Spalaris, C. N. Trans. Amer. Nucl. Soc., 10: 134-5 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38508 IRRADIATION BEHAVIOR OF U_3Si. Feraday, M. A.; Chalder, G. H.; Cotnam, K. D. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Trans. Amer. Nucl. Soc., 10: 123-4 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38509 IRRADIATION OF IMPACTED UO_2–PuO_2 PACKED POWDER FUEL. Bailey, W. J. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 121-3 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38510 INTERIM POSTIRRADIATION EXAMINATIONS OF SAXTON PuO_2–UO_2 FUEL RODS. Rolin, J. L.; McClintock, D. R. (Westinghouse Electric Co., Pittsburgh). Trans. Amer. Nucl. Soc., 10: 121 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38511 UNDERWATER CAISSON CONTAINMENT OF LARGE POWER REACTORS. Klepper, O. H.; Bell, C. G. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 328-9 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38512 REACTOR SAFETY AND SITING: A PROPOSED RISK CRITERION. Farmer, F. R. (United Kingdom Atomic Energy Authority, Risley, Eng.). Trans. Amer. Nucl. Soc., 10: 328 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38513 THE REACTIVITY BALANCE IN THE MSRE. Prince, B. E.; Engel, J. R. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 337 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38514 BEHAVIOR OF LONG-LIVED FISSION PRODUCTS IN SODIUM. Clifford, J. C. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 10: 336-7 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

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38578 BOLSA ISLAND NUCLEAR POWER AND DESALTING PROJECT. Wilson, William H. (Bechtel Corp., Los Angeles). Trans. Amer. Nucl. Soc., 10: 345(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38579 CONTROL SYSTEMS FOR OPTIMAL RESPONSE TO CHANGES IN LOAD DEMAND OF A NUCLEAR REACTOR PLANT. Duncombe, E. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 10: 367-8(June 1967).
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38580 HYDROGEN REACTIVITY CONTROL EXPERIMENT: PERFORMANCE AND RESULTS. Rosenthal, H. B.; Szymkowiak, E. A.; George, C. H. (Martin Marietta Corp., Baltimore). Trans. Amer. Nucl. Soc., 10: 366-7(June 1967).
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38581 TERRESTRIAL UNATTENDED REACTOR POWER SYSTEM: TURPS. Magladry, Robert (Martin Marietta Corp., Baltimore). Trans. Amer. Nucl. Soc., 10: 366(June 1967).
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38582 SPACE–TIME ANALYSIS OF NONLINEAR REACTOR SYSTEMS. Kastenberg, W. E. (Univ. of California, Los Angeles); Chambre, P. L. Trans. Amer. Nucl. Soc., 10: 250(June 1967).
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38583 OPTIMAL CONTROL OF SPATIALLY DEPENDENT NUCLEAR REACTORS. Hsu, Chun (Argonne National Lab., Ill.); Bailey, Robert E. Trans. Amer. Nucl. Soc., 10: 253-4 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38584 THERMAL CONDUCTIVITY OF MULTIPHASE CERAMIC NUCLEAR FUELS. Biancheria, A. (Westinghouse Electric Corp., Cheswick, Pa.). Trans. Amer. Nucl. Soc., 10: 100-1(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38585 FABRICATION OF A BWR ELEMENT WITH TWISTED TAPES BETWEEN THE FUEL RODS FOR THE KAHL EXPERIMENT NUCLEAR POWER PLANT. Bechtel, G.; Ruth, H.; Hoechel, J. (Allgemeine Elektricitaets-Gesellschaft AEG-Telefunken, Berlin). Kerntechnik, 9: 293-6(July 1967). (In German).

The manufacturing of 36 Zircaloy-2 fuel-rods, the processing of the fuel-element components, and the mounting of the boiling-water-reactor element with twisted tapes are described. The used test and manufacturing methods and the test results are explained. The boiling-water-reactor element with twisted tapes was placed in the

reactor of the Kahl nuclear power station at the beginning of November, 1966. Now it has reached a burn-up of about 2000 MWd/t. (auth)

38586 FUEL ACQUISITION: THE OUTLOOK FOR FINANCING. Witter, W. D.; McKeon, R. F. (William D. Witter, Inc., New York). Nucleonics, 25: 33-7; 44(June 1967).

The financing of nuclear power plants as a whole is examined; special emphasis is put on the projection of fuel values in terms of consumption and demand. A brief discussion of future financing of entire plants is given. (M.L.S.)

38587 INFLUENCE OF THE NUCLEAR POWER PLANTS ON THEIR SURROUNDINGS. Attila, Hejj. Energ. Atomtech., 20: 75-81(Jan.-Feb. 1967). (In Hungarian).

The waste disposal problems encountered by a nuclear power plant are discussed. Methods for handling liquid and gaseous radioactive wastes, containing radioactive dusts and gases, dispersing fission products into the atmosphere, and locating safe settlement sites are presented. (D.C.C.)

38588 FUEL COST ACCOUNTING: GIVING THE INVESTMENT ITS DUE. Carrs, Robert B. (Price Waterhouse and Co., New York). Nucleonics, 25: 39-44(June 1967).

The difference of investments in a nuclear power plant and a conventional power plant is discussed. Cost comparisons and financial accounting procedures for nuclear plants are presented. Questions of outright fuel purchase and piecemeal acquisition are discussed. (M.L.S.)

38589 CHAUNCEY STARR LOOKS AT THE U.S. NATIONAL REACTOR PROGRAM. Starr, Chauncey (Univ. of California, Los Angeles). Nucleonics, 25: 46-51(June 1967).

For savings in ore costs, various nuclear power programs are evaluated. Special emphasis is placed on the fast breeder development program. Tabular and graphical representations present the comparisons and requirements. Tables of economic comparisons are also presented. A discussion of economic factors is given. (M.L.S.)

38590 FASTER BREEDER CANNINGS FOR IRRADIATION EXPERIMENTS: MEASURING AND FABRICATION PROBLEMS. Kramer, W.; Will, H. (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik, 9: 285-8(July 1967). (In German).

Electrically heated pressure tubes were to be developed for irradiation tests. Following the description of the specimen, preliminary tests are dealt with, which were carried out to bring some light into the technical measuring problems and the questions of temperature behavior. The knowledge of the behavior of the specimens as a controlled system and the mastering of the technical measuring problems are of decisive importance for the evidence of the irradiation tests. Due to the smallness of the specimens fabrication gets particularly difficult; thus, special efforts are needed for welding. The specimens which are comparatively expensive because of their eminent fabrication requirements and precious because of the costs of irradiation, undergo a number of examinations after having been assembled. This is to ensure that only perfect specimens are placed into an irradiation rig. (auth)

38591 THE HANDLING OF FUEL ELEMENTS IN THE FIRST SWISS EXPERIMENTAL POWER STATION, LUCENS. Sommer, H. (Therm-Atom AG, Geneva). Kerntechnik, 9: 297-301(July 1967). (In German).

The principles of nuclear-fuel handling systems are briefly outlined. Practical applications of these principles on facilities of the Lucens experimental nuclear power station are then described. These facilities have the characteristics of a dispersed system, in which each machine has but a few specified functions. This conception guarantees the possibility of switching over to other handling cycles, which seems essential for an experimental reactor. (auth)

38592 STUDY OF THE CORROSION OF THE FEED-WATER SYSTEM OF THE GARIGLIANO NUCLEAR POWER PLANT. Della Rocca, Carlo; Cutarelli, Vincenzo; Tagiullo, Salvatore. Calore, 37: 331-44(1966). (In Italian).

An intensive set of analyses of samples taken at the significant points along the feed-water system has shown that the low pressure preheaters (3 units in Cu–Ni alloy) are the major contributors to soluble and insoluble Cu levels in the feed-water to the reactor. The apparent contribution of the high pressure heaters (2 units in Monel) is practically negligible. This is the more important conclusion of a work intended to assess the corrosion of the feed water system from the standpoint of transport of metals and metals oxides to the reactor system. An experiment is envisaged, in which bypassing the low pressure heaters, the contribution of the corrosion of the Monel secondary steam generators, to the deposit of Cu on the fuel elements, (appeared during the first operating period) can be assessed. If the latter contribution is negligible, it appears that the substitution of stainless steel in place of Cu–Ni and Monel alloys in the feed water heaters would be the obvious solution of the problem of Cu deposition on fuel. (auth)

38593 AEA REACTOR DEVELOPMENT. Elec. Rev., 179: 575-6(Oct. 14, 1966).

The reactor development program of the United Kingdom Atomic Energy Authority is briefly reviewed. Selection of the advanced gas-cooled reactor (AGR) for the Dungeness B plant is discussed. The reactivation of the diffusion separation plant at Capenhurst and the construction and siting of a 250 MW(e) prototype fast reactor are outlined. One reactor at Calder Hall has been refueled with elements having a herringbone heat transfer surface, resulting in increased output. The replacement of the original Windscale AGR fuel charge by fuel similar to that proposed for commercial AGR power stations has continued. The construction program of the 100-MW Steam-Generating Heavy-Water Reactor at Winfrith is described. A small magnetohydrodynamic generator is in use for the study of problems associated with the extraction of electrical power from a hot flowing gas. (J.C.W.)

38594 OUTLOOK FOR NUCLEAR POWER. Moore, R. V. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 59-64 of Fuel Economy, 1967. London, Confederation of British Industry, 1967.

The reactor development programme of the U.K.A.E.A., comprising AGR, HTR, SGHWR, and FR, is reviewed in relation to the present and future pattern of electricity generation in the U.K. (UK)

38595 ELECTRICAL SAFETY CIRCUITS IN A NUCLEAR POWER STATION. Taurit, Rudolf (Allgemeine Elektricitaetsgesellschaft, Frankfurt am Main). At. Strom, 13: 70-5(May-June 1967). (In German).

The importance of electrical safety circuits in a nuclear power station is discussed. Besides a discussion of the general criteria for a safety circuit, a short description is given of important installation systems which should be designed to incorporate safety circuits. In addition to reactor protection, these are the auxiliary systems which must be ready for action in case of a reactor breakdown or which may cause a reduction of availability due to faulty response. As an example the article discusses the 237 MW boiling water reactor power station at Gundremmingen. It gives the relative requirements, in a general form, which were worked out in the planning and development of this nuclear power station. (auth)

38596 THE USE OF THE FEINBERG–GALANIN METHOD FOR THE CALCULATION OF THE THERMAL-FLUX FINE STRUCTURE IN LIQUID-MODERATED NUCLEAR REACTORS. Jovanic, M. M.; Grant, P. J. (Imperial Coll. of Science and Tech., London). Brit. J. Appl. Phys., 18: 693-701(June 1967).

The Feinberg–Galanin method was used for the calculation of the thermal utilization and thermal-flux fine structure of cluster-type fuel elements in liquid-moderated reactors. The finite size of the fuel elements was taken into account, as was the possible presence of a thin absorbing wall between the fuel region and the main moderating region of the lattice. (UK)

38597 NUCLEAR REACTORS OF BELOJARSK-TYPE. Dollezjal, N. (NAUK, Moscow). Tek. Tidskr., 20: 489-92 (1967). (In Swedish).

The development of nuclear power reactors for commercial energy production in the Soviet Union has followed its own trend. The nearest equivalent is the first Pu producing reactor in the United States. Thus, graphite is used as moderator and light water as coolant. The pressure tube core has advantages compared with the pressure vessel type. The first reactor of 100 MWe has been in operation for two years. The next reactor to be constructed is of 200 MWe. A survey is given on the development history, design details, and operation experiences. (Sweden)

38598 FUTURE PROBLEMS IN THE CONVERSION, TRANSPORTATION, AND STORAGE OF ENERGY. ELECTRICITY: NEW SYSTEM OF POWER GENERATION: NUCLEAR. Karoly, Raszl. Energ. Atomtech., 20: 249-54(June 1967). (In Hungarian).

Detailed papers discussing the security and economy of nuclear energy are presented. A detailed review of some reactor types, their sizes and several properties, is given. The development of the breeding reactors to reduce the problems of fuel procurement for countries with no uranium sources is discussed. Other topics presented are: reactor operating costs; reactor building costs; selection of reactor type (fuel supply, experience of country, geological wealth of country, demand of capital, costs of energy generation, conditions of payment, and import demand); geographic

location (railway connections, density of inhabitants, and waste removal); hydrological circumstances (cooling water supply, and waste removal); and transmission lines (distance of networks and security aspects). Power generation by magnetohydrodynamic generators is also discussed. (D.C.C.)

38599 CONSTRUCTION OF A BOILER-SUPERHEATER UNIT FOR USE IN THE KAHL NUCLEAR TEST POWER STATION. Bechtel, Gerhard; Ruth, Heinrich; Hoechel, Jochen (Allgemeine Elektricitaetsgesellschaft, Frankfurt am Main). At. Strom, 13: 76-80(May-June 1967). (In German).

The manufacture of 12 boiler-superheater fuel tubes, the machining of the element components and the assembly of a complete boiler-superheater unit is described. The experience gained in the manufacture and assembly of the fuel elements serves as the basis for manufacturing specifications for the superheated-steam reactor element. (auth)

38600 SMALL POWER REACTORS FOR INDUSTRIAL APPLICATIONS. Kinsey, R. P. (United Kingdom Atomic Energy Authority, Risley, Eng.). J. Inst. Fuel, 40: 193-205(May 1967).

Industrial energy requirements throughout the world, fossil fuel resources, influence of nuclear energy on distribution networks, conventional and nuclear generating costs, potential applications, choice of system and design requirements, preferred designs, present UK programme, design features of integral PWR concept, core design and performance, and development potential are discussed for small power reactors. (UK)

38601 TEMPERATURE FIELDS OF FUEL ELEMENTS WITH LIQUID METAL COOLANTS. Subbotin, V. I.; Ushakov, P. A.; Zhukov, A. V.; Talanov, V. D. At. Energ. (USSR), 22: 372-8(May 1967). (In Russian).

Data on the experimental and analytical investigation of the temperature field and thermal emission in the active zone of reactors with hexagonal cell configuration were reported. The temperature fields of the fuel elements, separated into the central zone and near the plane wall of the cell, were examined. Some data on the overheating of the fuel element cladding under spacing ribs were given. The effects, with the consumption of the coolant through the cell cross section in the transition from turbulent to laminar flow regimes, were described. (tr-auth)

38602 CONTROL ROD OPERATION IN HIGH TEMPERATURE REACTORS. Emel'yanov, I. Ya.; Grebennikov, R. V. At. Energ. (USSR), 22: 367-71(May 1967). (In Russian).

Some data on the control and construction of high temperature rods and the absorbers used in them are reported. The steel rods with boride alloy absorbers at 600°C being transferred into dry channels with cooled walls and rods from graphite with rare earth absorbers used without special cooling in the active zone at 2200°C were described. (tr-auth)

38603 A LIQUID METAL RANKINE TOPPING CYCLE FOR A STEAM POWER PLANT. Gruntz, Robert D. (AiResearch Manufacturing Co. of Arizona, Phoenix). J. Spacecraft Rockets, 4: 859-64(July 1967).

The use of a K Rankine-cycle power system as a topping cycle for a steam power plant is described. A cycle efficiency of 50% can be obtained for a 5000-kWe plant. Ni and Co alloys, common to the well-established gas-turbine industry, could be used for the components. Turbines, bearings, seals, and a compact K boiler, which would also be directly applicable to the topping cycle, have been tested. Test results show that heat-transfer coefficients of the order of 50,000 Btu/hr-ft^2-°F can be achieved in the high-quality region. Also, stable boiling was readily obtained over a wide range of operating parameters. (auth)

38604 HOW TO GIVE CONTAINMENT VESSELS ELBOW ROOM. Power, 111: No. 8, 113(Aug. 1967).

A method of surrounding reactor containment vessels with concrete and yet allow necessary expansion and contraction is described. The method applies specifically to the Nine Mile Point Nuclear Station. The method involves placing forms reinforced with fiber glass 2 to 2½ in. from the containment vessel. Proper supports are provided for these forms and concrete is poured against them. The resulting breathing space—an air channel between the reactor enclosure and the concrete wall—serves as shielding and permits the steel vessel to expand and contract. (J.R.D.)

38605 NUCLEAR CONTRACTING WITHOUT TURNKEY. Patterson, R. W. (Sargent and Lundy, Chicago). Powwwer, 111: No. 8, 110-13(Aug. 1967).

It is noted that nuclear central-plant procurement is steadily developing a resemblance to the fossil-plant approach in which the power company contracts separately for engineering, equipment, and construction. Apart from economics and schedules, it is to the power company's advantage to have a continuing voice in the design of the plant, not just during the weeks of preparation of a unit specification, but right through construction. Typical equipment packages for nuclear steam supply systems are presented tabularly. Information is also included on evaluating bids, licensing, and plant design. (J.R.D.)

38606 R AND D FOR NUCLEAR PLANTS PAVED WAY FOR SAN ONOFRE. Roderick, C. Power, 111: No. 8, 104-5(Aug. 1967).

Benefits of the Large Closed-cycle Water Reactor Development Program as applied to the San Onofre Plant are described. Information is included concerning advanced fuel assemblies, improved nuclear design, fuel management, control systems, and the overall plant performance. (J.R.D.)

38607 SAN ONOFRE STARTS A NEW GENERATION OF NUCLEAR PLANTS. Strauss, Sheldon D. Power, 111: No. 8, 102-3(Aug. 1967).

A description of the plant is given. It is noted that advanced PWR design embodied in the plant is reflected primarily in the use of only three cooling-water loops for 450 MW operation as compared with Italy's four-loop Enrico Fermi Plant operating at 252 MW. Descriptions of steam generators, coolant pumps, reactor safety, fuel economy, and steam conditions are included. (J.R.D.)

38608 NUCLEAR POWER IN THE CPI. Butler, W. S. (Dow Chemical Co., Midland, Mich.). Chem. Eng. Progr., 63: No. 4, 39-40(Apr. 1967).

Nuclear power has become competitive with fossil-fuel-generated power in several areas. The effects of size, on-site power generation, fuel costs, pollution, and cost equalization of electrical power on the utilization of power by the chemical industry are discussed. (auth)

38609 POWER AND THE CPI: PARTNERS IN PROGRESS. Hines, E.; Wagner, H. A. (Detroit Edison Co.). Chem. Eng. Progr., 63: No. 4, 36-8(Apr. 1967).

The chemical industry is an important consumer of electric power and will benefit by lower costs made possible by nuclear power. Closer cooperation and examination of possible collaboration between the two industries for the use of electric power are warranted. Various aspects of the chemical power industry are examined in detail. Fuel reprocessing and isotope utilization are discussed. (auth)

38610 RADIOACTIVE INSPECTION OF AGR. Elec. Rev., 179: 889(Dec. 9, 1966).

Engineers have safely entered the AGR at Windscale. It is demonstrated that it is safe to carry out maintenance and inspection inside the pressure vessel of this type of reactor despite the presence of a full charge of radioactive fuel in the core. The entry was made during an annual maintenance and inspection shutdown. The Windscale AGR has been operating for 3½ yr and is the prototype reactor for the second nuclear power program of which the first station is now under construction at Dungeness. The reactor was built with an internal shield to reduce nuclear radiation to a level that would allow entry for inspection even with the reactor fully fueled. This design feature ensures that regular internal inspection and maintenance can be undertaken. (BBB)

38611 SOME ENGINEERING ASPECTS OF THE WINFRITH STEAM GENERATING HEAVY WATER REACTOR. Proceedings of a Symposium held in London, May 18, 1967. London, Institution of Mechanical Engineers, 1967. 139p. (CONF-670539).

The 9 papers presented, for which separate abstracts are prepared, report the history of the project and discuss the problems encountered and their solution in the design and construction of the components. (UK)

For abstracts of individual papers see: 38612–38619 and 38770.

38612 FAST-ACTING LIQUID SHUT-DOWN SYSTEM. Kirtley, W. F. (United Kingdom Atomic Energy Authority, Risley, Eng.); Shaw, M. K. pp 45-59 of Some Engineering Aspects of the Winfrith Steam Generating Heavy Water Reactor. Proceedings of a Symposium held in London, May 18, 1967. London, Institution of Mechanical Engineers, 1967.

See CONF-670539.

A shut-down system is described based on the pressurized injection of a liquid neutron-absorber through an in-line valve, the complete shut-down operation taking less than one second. The design evolution is discussed, and also the developments necessary to confirm equipment reliability and performance characteristics. Manufacture, site testing, and commissioning procedures are reviewed. (UK)

38613 THE WINFRITH SGHWR. Cartwright, H. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 5-12 of

Some Engineering Aspects of the Winfrith Steam Generating Heavy Water Reactor. Proceedings of a Symposium held in London, May 18, 1967. London, Institution of Mechanical Engineers, 1967. See CONF-670539.

The symposium is introduced and the relationship is shown between the other papers presented. The SGHWR power plant is described briefly, and the main parameters are given. Mention is made of the role of the mechanical engineer in the design of the plant, and the project management is discussed. (UK)

38614 CALANDRIA AND NEUTRON SHIELDS. Greenhalgh, F. G. (United Kingdom Atomic Energy Authority, Risley, Eng.); Paget, F. T. W.; Smith, D. R.; Truelove, J. P. pp 31–44 of Some Engineering Aspects of the Winfrith Steam Generating Heavy Water Reactor. Proceedings of a Symposium held in London, May 18, 1967. London, Institution of Mechanical Engineers, 1967. See CONF-670539.

The critical nature of these items in the overall construction programme, and the consequent high quality and reliability required, is emphasized. The calandria of all-welded construction is Al–2.75% Mg alloy contains 112 tubes 0.13 in. thick on a 10.25 in. square lattice pitch. The vessel temperature is kept below 90°C by the D_2O recirculation system which maintains a downward flow. In the eventual neutron shield design steel/water shields are incorporated in a composite arrangement with concrete, and the core is supported by the upper and lower neutron shields which are designed as support grids. Design and manufacturing problems encountered are discussed, and the solutions arrived at are explained. (UK)

38615 REACTOR PRIMARY CIRCUIT. Boocock, P. M. (United Kingdom Atomic Energy Authority, Risley, Eng.); Warren, L. W. pp 61-79 of Some Engineering Aspects of the Winfrith Steam Generating Heavy Water Reactor. Proceedings of a Symposium held in London, May 18, 1967. London, Institution of Mechanical Engineers, 1967.
See CONF-670539.

The SGHWR primary circuit consists of a light water system, heated via pressure tubes in the reactor core. The design is reviewed, with particular reference to layout, selection of pipe sizes, flow measurement, thermal shock considerations, steam dump facilities, and items associated with plant integrity. Certain construction aspects are reviewed, and the paper covers testing at site. The circuit and components do not limit reactor output and size. (UK)

38616 ROTATING SHIELDS. Emerson, D. C. (United Kingdom Atomic Energy Authority, Risley, Eng.); Flett, A. pp 81-97 of Some Engineering Aspects of the Winfrith Steam Generating Heavy Water Reactor. Proceedings of a Symposium held in London, May 18, 1967. London, Institution of Mechanical Engineers, 1967.
See CONF-670539.

The shields, the design of which is described, position the refuelling machine containments, and protect the operators. The problems of the design of the bearings and of the seals were solved by the use of an oil hydrostatic bearing. Other features of the design discussed include the drive and positioning system, structural analysis, biological shielding, and cable laying across the shields. The manufacturing, and erection and testing procedures are described. (UK)

38617 REFUELLING MACHINE. Dawson, D. J. (United Kingdom Atomic Energy Authority, Risley, Eng.); Guild, J. C.; Floud, R. C. pp 99-113 of Some Engineering Aspects of the Winfrith Steam Generating Heavy Water Reactor. Proceedings of a Symposium held in London, May 18, 1967. London, Institution of Mechanical Engineers, 1967.
See CONF-670539.

An outline is given of the engineering principles behind the design of the on-load system which is described. Design, manufacture, and development problems discussed include the mechanism drives, nose unit, materials, fuel integrity sensor, and weight sensing system. Mention is made of the safety and safeguards, and of the operational integration of the machine with the associated reactor plant. The comprehensive testing programme necessary to obtain reliability in a "on-off" design is summarized. (UK)

38618 STEAM TURBINE AND ASSOCIATED PLANT. Harris, F. R. (Associated Electrical Industries Ltd., Eng.); Knott, H. pp 115-30 of Some Engineering Aspects of the Winfrith Steam Generating Heavy Water Reactor. Proceedings of a Symposium held in London, May 18, 1967. London, Institution of Mechanical Engineers, 1967.
See CONF-670539.

The adaption of normal steam turbine design and manufacturing practice necessary to meet the special requirements of the SGHWR system is described. The basic data of the generating set are: rated output 100 MW, inlet steam conditions 90 psi dry sat. (279°C), average cooling water temperature 19°C, final feed temperature 198°C. A cost and efficiency optimization study resulted in a gross thermal efficiency at 100 MW of 34.5%. The specific design aspects discussed include the effect of low steam conditions and water removal, steam dissociation, corrosion and erosion, radioactivity and shielding, turbine governing, and steam dumping. The stretch capacity is also briefly discussed. (UK)

38619 PROJECT MANAGEMENT. Firth, A. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 131-7 of Some Engineering Aspects of the Winfrith Steam Generating Heavy Water Reactor. Proceedings of a Symposium held in London, May 18, 1967. London, Institution of Mechanical Engineers, 1967.
See CONF-670539.

A description is given of the management, and the cost and programme control of the SGHWR project from the date of sanction, and of the planning techniques used. A comparatively simple system incorporating a modified critical path method has enabled the completion date to be met. (UK)

38620 FAST NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,381,991. Nov. 2, 1964. Priority date Feb. 11, 1963, Great Britain.

A water cooled fast reactor is described in which elongated fuel elements are applied, the elements having an external diameter of 5 mm, a heat transfer surface of at least 240 m^2/m^3, and containing ceramic fuel that is enriched with Pu. The coolant is maintained under supercritical pressure and is preheated in such a manner before entering the reactor core that its temperature rise in the core is below 200°C. The core is mounted in a double walled vessel, the supercritical coolant passing through the annulus between the two walls. The outgoing coolant is divided into two streams, the minor first stream being sent directly to the turbines while the major second stream is used to reheat the first stream and is then recirculated. (NPO)

38621 SOLID FUEL ELEMENT FOR NEUTRONIC REACTOR. (to U.S. Atomic Energy Commission). French Patent 1,234,411. May 16, 1960. Priority date Aug. 8, 1958, United States.

A graphite jacketed fuel element for high temperature gas cooled reactors, which is provided with an internal and/or external fission product trap, is described. (NPO)

38622 FUEL ELEMENT FOR A HIGH-TEMPERATURE GAS-COOLED REACTOR. (to U.S. Atomic Energy Commission). French Patent 1,248,261. Oct. 31, 1960. Priority date Mar. 27, 1959, United States.

A rigid fuel element for a high temperature gas cooled reactor, comprising a first graphite sleeve, which is inserted in a second graphite sleeve, with the sleeves being spaced from each other by means of (integral) longitudinal graphite fins, is described. The first sleeve may act as a tightly fitting can for the nuclear fuel or it may tightly envelop a metal canned fuel element. A number of these fuel elements may be assembled in a graphite supporting tube. (NPO)

38623 DEFLECTING CHANNELS FOR NUCLEAR REACTOR FUEL ELEMENTS. Huet, A. French Patent 1,212,200. Oct. 19, 1959. Filed Sept. 12, 1958.

The walls of the fuel channels in a boiling water reactor are undulated which improves heat transfer. In addition, the wall of the fuel element may be undulated or provided with longitudinal fins. The undulations and fin disposition may vary with the axial location in the reactor core. The interior wall of a fuel tube is also undulated. All undulations may be applied in helices. (NPO)

38624 FUEL ELEMENTS FOR NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,224,478. Feb. 8, 1960. Priority date May 14, 1958, Great Britain.

A core element for the Dragon nuclear reactor, comprising a graphite sleeve in the interior axial cavity of which fuel rings are mounted on a graphite spine, is described. Fission gases are removed by means of a purge gas which enters the element via a system of permeable graphite plugs. (NPO)

38625 REVIEW OF NUCLEAR REACTOR PROGRAMME. Stewart, J. C. C.; Fry, D. W.; Marsham, T. N.; Searby, P. J. London, Her Majesty Stationary Office, 1967. UK 3s. 0d.

The minutes taken at Atomic Energy Establishment, Winfrith, before Parliamentary Select Committee on Science and Technology, 16th June 1967 are presented. (auth)

Marine and Portable Power Reactors

38626 THE ANGLO–BELGIAN SMALL POWER REACTOR DEVELOPMENT. Brussels, Societe Anglo-Belge Vulcain S. A., 1967. 17p.

The BR3/Vulcain experimental programme which is described is designed to demonstrate an advanced core design using a variable H_2O/D_2O mixed moderator particularly suitable for land based and marine applications in the range 20 to 60 MW(e). (UK)

Rocket and Space Reactors

Refer also to abstracts 36781 and 36790.

38627 (NAA-SR-11520) DISASSEMBLY AND POSTOPERATION EXAMINATION OF THE SNAP 8 EXPERIMENTAL REACTOR. Dyer, R. E. (Atomics International, Canoga Park, Calif.). June 30, 1967. Contract AT(04-3)-701. 53p. Dep. CFSTI.

A discussion of the shutdown and disassembly of the SNAP-8 Experimental Reactor and of the postoperation evaluation of the heat transfer system, the reflectors, and portions of the core. Information regarding material compatibility with system operation conditions was compiled. The reactor was shut down after 12,000 hr of operation, which included 100 days at 600 kwt, and over 1 year at 400 kwt or greater. The core coolant outlet temperature was 1300°F in both cases. (auth)

38628 (NASA-TN-D-4095) DESIGN AND PERFORMANCE OF A NUCLEAR REACTOR SIMULATOR FOR NONNUCLEAR TESTING OF SPACE POWER SYSTEMS. Jefferies, Kent S.; Packe, Donald R.; Dittrich, Ralph T. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Aug. 1967. 34p. CFSTI.

The design of a SNAP-8 reactor simulator is presented. An analog computer and an electric heater were used to simulate the reactor nucleonics and control and the thermodynamics, respectively. Performance of the analog system was analyzed by a digital computer model of SNAP-8. Effects of ramp and step coolant temperature perturbations are discussed. (M.L.S.)

38629 (UCID-15168) PRELIMINARY THOUGHTS ON REACTOR OPTIMIZATION CRITERIA. Space Power Note No. 225. Brown, Norman (California Univ., Livermore. Lawrence Radiation Lab.). July 7, 1967. 18p. Dep. CFSTI.

The selection of the optimum fuel element configurations for reactors covering the range from 1 to 100 Mw is examined briefly, and a few preliminary criteria are established for a first approximation. (auth)

38630 (WANL-TME-537(Rev.1)) REVISED FISSION PRODUCT INVENTORY PROGRAM (FPIP-REV). Brown, W. S.; Call, D. W. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). May 1967. 73p. Dep. CFSTI.

FPIP-REV calculates the time behavior of 254 fission product nuclides formed by fissioning of ^{235}U resulting from a specified reactor operating history. The operating history can consist of as many as six separate operating periods, each at an arbitrary power level. The activity is calculated for each nuclide and summed for the total inventory. The program calculates the γ and β radiation energy source strengths (MeV/sec) in each of seven γ and five β energy groups versus decay time after final shutdown. Also, for each decay time, the integrated γ and β source strengths (MeV) per group are determined over a specified time span immediately subsequent to that decay time. The program has been used within the ROVER Program to predict fission product inventories and source strengths associated with operation of the NERVA reactor. Data used in the program library for the physical constants of the fission product nuclides, chain branching ratios, etc., are the same as those values used by USNRDL. Five limitations of the program are listed. (J.C.W.)

38631 COMPARISON OF BERYLLIUM PHOTONEUTRON DECAY SETS USING EXPERIMENTAL SNAP REACTOR DATA. Ottewitte, Eric H. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 10: 180(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38632 AN ANALYSIS OF THE KIWI-TNT EXPERIMENT WITH MARS. Klickman, A. E.; Hirakawa, N. (Atomic Power Development Associates, Inc., Detroit). Trans. Amer. Nucl. Soc., 10: 246(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38633 REACTOR POWER SYSTEM REQUIREMENTS FOR MANNED ORBITAL SPACE MISSIONS. Ross, F. A.; Plunkett, T. F. (Douglas Aircraft Co., Inc., Santa Monica, Calif.). Trans. Amer. Nucl. Soc., 10: 12(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38634 SPACE-DEPENDENT DYNAMICS OF NUCLEAR PROPULSION ENGINES. Woyski, Jan S. (Douglas Aircraft Co., Inc., Santa Monica, Calif.). Trans. Amer. Nucl. Soc., 10: 11-12(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38635 FCX INITIAL CRITICALITY EXPERIMENTS AND ANALYSIS. Freidhof, W. E.; Barksdale, C. E.; Mowery, A. L.; Bevard, D. G. (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 10: 10-11(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38636 A SIMPLE TECHNIQUE FOR ESTIMATION OF THE REACTIVITY WORTH OF STRUCTURES EXTERNAL TO A NERVA REACTOR. Hill, D. J.; Ortenberg, L. I.; McCutchan, D. A. (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 10: 9-10(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38637 THE DETERMINATION OF AIRBORNE RADIOACTIVITY DURING NERVA REACTOR TESTING. Rymer, G. T.; Henninger, W. A.; Grandy, G. L. (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 10: 1-2(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38638 MODELS FOR ESTIMATING PARTICLE RETENTIONS OF HUMANS AND CONSEQUENT BETA DOSES FROM DEBRIS IN AEROSPACE NUCLEAR APPLICATIONS. Kochendorfer, D. B.; Ulberg, J. C. (Naval Radiological Defense Lab., San Francisco). Trans. Amer. Nucl. Soc., 10: 2-3(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38639 RADIONUCLIDE FRACTIONATION AND LEACHING OF TRANSIENT NUCLEAR TEST DEBRIS. Lai, J. R.; Freiling, E. C. (Naval Radiological Defense Lab., San Francisco). Trans. Amer. Nucl. Soc., 10: 3-4(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38640 FISSION-PRODUCT ACTIVITY IN THE OPERATING AEROSPACE REACTOR. Kitzinger, David G. (Sandia Corp., Albuquerque, N. Mex.). Trans. Amer. Nucl. Soc., 10: 4-5 (June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38641 PERFORMANCE LIMITATIONS ON A RADIATING LIQUID-CORE NUCLEAR ROCKET DUE TO SUPPORT-WALL TEMPERATURE REQUIREMENTS. Putre, Henry A. (Lewis Research Center, Cleveland). Trans. Amer. Nucl. Soc., 10: 356(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38642 EFFECT OF TURBULENCE ON RADIANT HEAT TRANSFER IN A GASEOUS-CORE NUCLEAR ROCKET ENGINE. Kascak, Albert F. (Lewis Research Center, Cleveland). Trans. Amer. Nucl. Soc., 10: 354-6(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38643 THE IRRADIATION OF STOICHIOMETRIC AND HYPOSTOICHIOMETRIC UO_2–PuO_2 FUELS TO EXPOSURES OF 125,000 MWD/MT. Rubin, B. F.; Nelson, R. C.; Perry, K. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc., 10: 102-3(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38644 ONE-DIMENSIONAL CALCULATIONS OF NERVA REACTOR CONTROL SPANS. Stefanko, J.; Mowery, A. (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 10: 201-2(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38645 SPACE REACTOR SHIELDING: LITHIUM HYDRIDE LABORATORY STUDIES. Welch, Frank H. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 10: 139(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38646 OXIDATION KINETIC STUDIES ON SNAP FUELS. Young, William A. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 10: 126-7(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38647 SNAP 10A DATA REDUCTION. Berg, G. E. (Atomics International, Canoga Park, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 4, 2-10(Aug. 1967).

On April 3, 1965 the world's first nuclear reactor space power system, SNAP 10A, was launched and operated successfully for forty-three days in orbit. To reduce and analyze the flight test data, data handling procedures and data analysis computer programs representing the end results of three years of effort and improvement of similar data systems for SNAP 10A ground tests were used. The evolution of data handling and reduction from the manual methods used for the first non-nuclear system test to later ground tests where data loggers of increasing degrees of sophistication were used to generate punched paper tape which was then computer processed, reduced, and analyzed, and finally to the completely electronic and computerized reduction of flight test telemetry data are described. The equipment used, handling procedures developed, and computer programs are briefly described. Improvements in each generation of data system resulting from experience and improved equipment are emphasized. As a result of the experience in semi-automatic data collection, reduction, and analysis gained in the SNAP 10A program recommendations for creation and improvement of similar data systems are given, and some of the more important pitfalls encountered are discussed. Finally, the more significant differences between flight and ground acquisition and reduction are noted. (auth)

38648 ALKALI-METAL, RANKINE-CYCLE POWER SYSTEMS FOR ELECTRIC PROPULSION. Zipkin, Morris A. (General Electric Co., Cincinnati). J. Spacecraft Rockets, 4: 852-8(July 1967).

The development of alkali-metal Rankine-cycle power systems for electric propulsion of spacecraft is discussed. The reference design is detailed; materials development and compatibility are discussed at length. Results from operations tests with the helical induction EM pump, EM boiler feed pump, and potassium turbine tests are tabulated. (M.L.S.)

38649 SNAP 8 REACTOR BEARING DEVELOPMENT. Kellogg, L. G.; Dewart, W. G. (Atomics International, Canoga Park, Calif.). Contract AT(11-1)-GEN-8. ASLE (Amer. Soc. Lubric. Eng.) Trans., 9: 322-35(1966).

The SNAP 8 reactor bearings are designed to provide low-friction self-lubrication at 1150°F while in the environment of a nuclear reactor operating in space. The bearings must also be designed to operate without repair or replacement of parts through their life of 10,000 hr, during which time total radiation doses of fast neutrons to 10^{20} nvt and γ rays to 10^{11} rad will be received by the bearings. A 4-phase program is described that has successfully developed these low-speed, oscillating bearings. Phase One was the study and screen testing of static adhesion of bearing materials. Phase Two was the study and screen testing of bearing materials in sliding couple. Phase Three was the application of the bearing materials into bearing designs where prototypes were fabricated and tested. Phase Four was the optimizing and testing of the final designs for reactor ground test in poor vacuum (10^{-5} torr), and simulated space, i.e., ultrahigh clean vacuum (10^{-9} torr). Results of shock and vibration tests are also presented. Mechanical C-graphite in sliding couple with Al_2O_3-coated metals proved to be a low-friction, low-wear bearing material combination for SNAP 8 reactor component bearings. (BBB)

Process Heat and Desalination Reactors

Refer also to abstracts 35933, 35934, 35999, 36049, 36808, 38577, and 38578.

38650 THE UNITED STATES GOVERNMENT DESALINATION PROGRAM. Coley, Francis H. (Dept. of the Interior, Washington, D. C.). Metals Eng. Quart., 7: No. 3, 1-4(Aug. 1967).

The Office of Saline Water has been charged by the Congress with the responsibility for development of economical processes for desalination of water. This program is important to many localities within the United States where supplemental water sources are needed or where the supplies now in use are of inferior quality. It also offers opportunities to improve the lot of people abroad and may aid in prevention of disputes between nations. As currently pursued, the Saline Water Conversion Program encompasses all phases of research and development. The research program probes the fundamentals of water, salts, materials of constructions, and phenomena that may have application in new or improved processes. The engineering and development program directed toward the development of technology for promising processes and toward demonstrations of economic feasibility for some of these processes is described. (auth)

38651 DUAL-PURPOSE NUCLEAR POWER-DESALTING PLANT IN SOUTHERN CALIFORNIA. Wang, G. S. C. (Bechtel Corp., Vernon, Calif.). Metals Eng. Quart., 7: No. 3, 5-10(Aug. 1967).

The important engineering and economic factors considered in the feasibility study for the world's largest power and desalination plant are presented. The dual-purpose plant, providing 150 mgd of desalted water and 1800 MW of power, is to become operational in 1971. (auth)

38652 COMBINATION NUCLEAR POWER AND DESALTING PLANTS. Comtois, Wilfred H. (Westinghouse Electric Corp., Pittsburgh). Mech. Eng., 89: No. 8, 16-20(Aug. 1967).

Various aspects of optimization and economic characteristics of nuclear-powered combination electric-generating, water-desalting plants are examined. Three cycles being studied for combination plants are illustrated and economic factors are discussed with the objective of minimizing the unit cost of water. (H.D.R.)

38653 COSTS OF POWER FROM NUCLEAR DESALTING PLANTS. Sindt, H. A. (Atomic Energy Commission, Washington, D. C.); Spiewak, I.; Anderson, T. D. Chem. Eng. Progr., 63: No. 4, 41-5(Apr. 1967).

Studies of the practicability of extrapolation of nuclear power plants to 10,000-MW(t) single-unit sizes were completed. Reactors of this size are anticipated for use in large desalting complexes in the 1980's and beyond. The costs and quantities of electric power generation from such large nuclear power desalting plants were estimated. (auth)

38654 PROCESS HEAT COSTS AND NUCLEAR POWER. Bernsen, S. A.; Schmitz, R. P. (Bechtel Corp., San Francisco). Chem. Eng. Progr., 63: No. 4, 65-7(Apr. 1967).

A method for calculating nuclear fuel cycle costs is described, and capital costs for typical plants are estimated. The cost of process heat is presented on the basis of appropriate allocation of plant and fuel costs to steam and electricity for varying values of by-product electricity. (auth)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 36073, 36805, and 38191.

38655 (AECL-2707) INTEGRAL NEUTRON SPECTRUM MEASUREMENTS IN HEAVY WATER LATTICES AND A COMPARISON WITH THEORY. Green, R. E.; Kay, R. E.; Halsall, M. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). June 1967. 18p. (CONF-670707-16). Dep. CFSTI. CAN $1.00.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich.

Experiments have been performed in the ZEEP and ZED-2 critical facilities at Chalk River to obtain information about the neutron spectrum in lattices of natural U fuel in heavy water moderator. Studies have been made in lattices containing clusters of U, UO_2, and UC having D_2O, air and organic liquids as coolants, all at room temperature, and some experiments with UO_2 fuel have investigated the effect of changing the coolant temperature. Integral neutron spectrum measurements that were made in both the fuel and moderator regions of lattice cells by activating foils containing In, Mn, and Lu are described. The relative $^{116}In/^{55}Mn$ and $^{177}Lu/^{55}Mn$ activity ratios have been compared with calculated ratios obtained from HAMMER, a multigroup, multiregion integral transport theory code, SOLO, a multigroup, multiregion collision probability code and MULTIGRO, a multigroup, two-region diffusion theory code. The activity ratios have also been interpreted in terms of the Westcott epithermal index, r, and effective neutron temperature, T_n. Experiment and theory are compared for selected lattices to illustrate the effect upon the neutron spectrum of fuel material, cluster geometry, coolant composition, and coolant temperature. (auth)

38656 (BNL-11556) RELATIONSHIP BETWEEN PULSED, POISONING, AND WAVE EXPERIMENTS. Michael, Paul; Moore, M. N. (Brookhaven National Lab., Upton, N. Y.). July 1967. 22p. (CONF-670707-12). Dep. CFSTI.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich.

The relationship between the pulsed source experiment and neutron wave experiment is demonstrated. The pulsed source experiment uses a generalized dispersion law to characterize the system and thereby determine the relationship between the pulse parameters and wave parameters. The neutron wave experiments utilize the wave frequency-dependent eigenvalue of the Boltzmann operator. A formulation of translation parameters from one system to another is given. 17 references. (M.L.S.)

38657 (BNL–11561) WATER QUALITY CONTROL IN THE HFBR. Protter, S. R. (Brookhaven National Lab., Upton, N. Y.). June 1967. 16p. Dep. CFSTI.

Sampling procedures, preparation of D_2O standards, infrared techniques for detecting small changes in D_2O purity, semiautomatic colorimetric techniques for determining chlorides, nitrates and nitrites, and in-line and laboratory pD measurements are covered. Analytical data are presented and evaluated. Operating experiences in maintaining the primary D_2O under oxidizing and reducing conditions in the reactor cover gas are also discussed. (auth)

38658 (BNL–11585) HEAT EXCHANGER TUBE VIBRATION AND REPAIR IN THE HIGH FLUX BEAM REACTOR. Kinne, G. C.; Tichler, P. R. (Brookhaven National Lab., Upton, N. Y.). July 19, 1967. 9p. (CONF-670713–3). Dep. CFSTI.

From 3rd Meeting of the Reactor Operations Division of the American Nuclear Society, Atlantic City, N. J.

A rattling was discovered in the coolers of the High Flux Beam Reactor during early operation. At about one-half the rated flow of cooling water the rattling disappeared, but an investigation followed to determine the problem. Measurements of vibration amplitudes were made in various tubes and the conclusions are outlined. Equipment modifications were made and the cost determined. (J.C.W.)

38659 (BNL–50035) URANIUM–WATER LATTICE COMPILATION. PART I. BNL EXPONENTIAL ASSEMBLIES. Price, Glenn A. (Brookhaven National Lab., Upton, N. Y.). Dec. 30, 1966. 279p. Dep. CFSTI.

The Brookhaven National Laboratory exponential experiments with the lattice specifications are recorded for the further development of theoretical models and neutron cross section libraries necessary for the design of power reactors. The experiment to determine cadmium ratios is described. An appendix summarizes some of the ρ_{28}^{8} measurements. Measurements of the thermal disadvantage factor ζ^{Dy} are accomplished by irradiating small Dy foils in a fuel rod and in water. This technique is explained in an appendix. A fission catcher technique is used to measure the fast-to-thermal fission ratio, δ_{28}^{25}. Two techniques for measuring material buckling in exponential assemblies are described. A bibliography of 100 references is included. (J.C.W.)

38660 (BNWL–393) THEORY EXPERIMENT CORRELATION OF BURNUP DATA FROM Al–1.8 WT.PERCENT Pu FUEL (INITIALLY 6 AT.PERCENT ^{240}Pu). Page, L. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1967. Contract AT(45-1)-1830. 16p. Dep. CFSTI.

As a result of the correlation study the cross sections adequately predict experimental isotopic concentrations and effective cross section ratios for Pu–Al fuel as concluded from the experimental data. Analytical results agreed with experimental results up to approximately 33% burnup; and it is felt that the discrepancies for larger values of burnup may be attributed to the fact that THERMOS is not adequate for cross section calculations involving the ^{240}Pu resonance. The analytical methods used for the correlation, the HRG-THERMOS-Program S series of calculations, produced a difference of 5.8 mk in K_∞ due to differences between the computed and experimental concentrations of ^{241}Pu and ^{242}Pu. Since the reactivity difference came at about 48% burnup and was zero below 33% burnup, the concentration uncertainty is probably negligible for most reactivity calculations. It was also found that use of program THERMOS in the region of the ^{240}Pu resonance allowed the computation of the experimental concentration of ^{241}Pu up to the point where the atom ratio $^{240}Pu/^{239}Pu$ was 0.20. At larger values, the average ^{240}Pu absorption cross section is computed too small using THERMOS and too large using Program HRG. (auth)

38661 (BNWL-SA-1269) PLUTONIUM RECYCLE TEST REACTOR (PRTR) OPERATING EXPERIENCE AND SUPPORTING R AND D. ITS APPLICATION TO HEAVY WATER POWER REACTOR DESIGN AND OPERATION. Harty, H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 27, 1967. Contract AT(45-1)-1830. 13p. (CONF-670917–1). Dep. CFSTI.

From Symposium on Heavy Water Power Reactors, Vienna, Austria.

Data correlating pressure tube reactors in the areas of pressure tube technology, heavy water management, component performance, and unique heavy water reactor operations to power plants are discussed. The reactors whose operating experience most closely parallels the heavy water power reactor are the CVTR and PRTR. (J.C.W.)

38662 (EUR–3491.e) THERMOCOUPLE FAILURES IN GRAPHITE IRRADIATION RIGS FOR BR 2 REACTOR, MOL. Patane, M. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). May 11, 1967. 15p. Dep.

Probable reasons are discussed for thermocouple failure during irradiation in graphite experimental devices. It was found that an adverse combination of the thermocouple-sheath material, the purity of the insulation used for the thermocouple wires, and the ambient atmosphere during irradiation, can give the sort of destruction observed in these thermocouples during disassembly of the experimental device in a hot cell. (auth)

38663 (GEAP–5486) PLUTONIUM SUBCRITICAL EXPERIMENT PROGRAM. Quarterly Report No. 11, January 1–March 31, 1967. Carver, J. G. (General Electric Co., Pleasanton, Calif. Nuclear Technology Dept.). Apr. 3, 1967. Contract AT(04-3)-189. 12p. (EURAEC–1837). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

A discussion of the data acquisition from resonance beads irradiated in the first subcritical Pu lattice is discussed. The irradiations presently underway are outlined. The assembly of a second lattice with a different fuel-to-water ratio is discussed briefly. (M.L.S.)

38664 (KAPL–M–6701) CATALOGUE OF SHA EXPERIMENTS AND CALCULATIONS. Supplement I. Weinstein, S.; Reiter, R. A. (Knolls Atomic Power Lab., Schenectady, N. Y.). May 1967. Contract W-31-109-eng-52. 18p. Dep. CFSTI.

Eight additional SHA critical configurations were assembled using the first and second solid homogeneous fuel materials and an assortment of internal and external reflectors. The experimental values of the effective multiplication constants, dimensional drawings of the systems, and details of their construction are presented as a supplement to the SHA catalogue. (auth)

38665 (NASA-TM–X–1418) CALCULATION OF FAST-NEUTRON FLUX EMERGING FROM A REACTOR BEAMHOLE AND COMPARISON WITH EXPERIMENT. Bloomfield, Harvey S. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Aug. 1967. 16p. CFSTI.

A comparison of calculated and measured fast-neutron fluxes emerging from the HB-6 beamhole of the NASA Plum Brook reactor is presented. Integrated dose rates were calculated with the QAD line-of-sight computer program using Albert-Welton removal theory to account for neutron attenuation. The program output was converted to fast flux with the Snyder-Neufeld conversion factors and then modified by the use of collimated removal cross sections to account for the reduction of the scattered flux component emerging from the duct. In addition, the use of neutron removal theory in nonhydrogenous media was assumed valid because of recent measurements. Measured flux values were calculated from sulfur foil activation data and then extrapolated to a lower energy of 0.3 MeV (0.048 picojoule) to correspond to the conventional energy range of the calculational method. The extrapolation was carried out by using both a fission spectrum and a beryllium altered fission spectrum. These spectra were chosen to represent the possible extremes of the true duct spectrum, which was estimated to be a hardened fission spectrum. Results of the comparison indicate that the calculational method can predict fast-neutron fluxes emerging from the HB-6 beamhole to within a factor of about 1.5 when suitable corrections to the method are applied. (auth)

38666 (NP–16873) EXPERIMENTAL AND THEORETICAL STUDIES OF MATERIAL BUCKLING AND DIFFUSION COEFFICIENTS IN SINGLE- AND MULTI-REGION NUCLEAR REACTOR LATTICES. Persson, Rolf (Chalmers Tekniska Hogskola, Goteborg (Sweden)). 1966. 15p. Dep.

Thesis.

An interpretation is given to the various kinds of buckling measurements performed in heavy water moderated exponential and critical facilities. Problems connected with boundary transients, anisotropy, and heterogeneity are discussed. The experiments adapt to the one-group and two-group models; single-region cores regarding higher harmonics, spectral transients, and heterogeneity effects in flux distributions; multi-region cores regarding differences in diffusion coefficients, spectral transients between regions, and buckling equivalence of control rods. Individual analytical abstracts of preprints appear in Nuclear Science Abstracts as NSA 11: 2139; NSA 16: 15766; NSA 16: 29993; NSA 18: 33035; NSA 19: 17200; NSA 20: 40377; NSA 21: 5677; NSA 21: 14061; and

Preprint No. V, which is going to be published in a revised form in Nukleonik and will be abstracted when it appears to public. (Sweden)

38667 (NYO-1859-13) TWELFTH ANNUAL PROGRESS REPORT [ON NUCLEAR REACTOR FACILITY], JULY 1, 1966–JUNE 30, 1967. Ross, Donald A. (Pennsylvania State Univ., University Park. Dept. of Nuclear Engineering). June 1967. Contract AT(30-1)-1859. 44p. (PSR-315-496775). Dep. CFSTI.

An operations history of the Pennsylvania State TRIGA Reactor is presented. Also given is an operations history of the ^{60}Co Gamma Facility. Education and training utilization is discussed; research utilization is tabulated. The Pennsylvania State University Research Projects are outlined. A list of 25 topical reports produced for the year of July 1, 1966 to June 30, 1967 is given. (M.L.S.)

38668 (ORNL-CDC-1) CRITICALITY OF LARGE SYSTEMS OF SUBCRITICAL U(93) COMPONENTS. Thomas, J. T. (Oak Ridge National Lab., Tenn.). Aug. 1967. Contract W-7405-eng-26. 37p. Dep. CFSTI.

Methods for estimating the number of components required for criticality of unreflected and paraffin reflected systems of subcritical units are described. A neutron nonleakage fraction parameter is defined and leads to a correlation confirmed to within 5% of the number of units by comparison with experimental data for three dimensional cuboidal arrays. A density analogue representation of the arrays is readily derivable and is shown to approximate the results from the above method, but is less precise. Factors by which the number of units in an unreflected critical array is reduced by adding a paraffin reflector are found to range from about six to greater than 30 depending on the material and on the average uranium density considered. The methods are supported by Monte Carlo calculations demonstrated to be reliable by comparison with the results of critical experiments. (auth)

38669 (RFP-907) ENRICHED URANIUM-METAL MEASUREMENTS, NO. 1. Tuck, Grover (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). July 26, 1967. Contract AT(29-1)-1106. 38p. Dep. CFSTI.

The critical masses of oil-reflected and moderated enriched uranium (93.12%, uranium-235) spherical and hemispherical shell assemblies have been measured at inside radii of 0, 4, 6.67, 8, and 12 centimeters (cm). The measurements are described and compared to calculated values for spherical assemblies. (auth)

38670 (RISO-M-584) POSSIBLE NEW FUEL ELEMENT TYPES FOR THE DR 3 REACTOR. REACTOR PHYSICS CALCULATIONS. Suhr, Per B. (Danish Atomic Energy Commission, Risoe. Research Establishment). June 15, 1967. 16p. Dep.

In connection with a change to new fuel element types for the DR 3 reactor a number of calculations have been performed on the distribution of fast and thermal fluxes in fuel elements of the MTR Mk. 4 type. Also some reactivity calculations have been made. Different types of Mk. 4 elements are produced by distributing a given amount of uranium among three or four concentric fuel tubes. One of the advantages of the Mk. 4 fuel element with uranium distributed among four fuel tubes—as compared with the Mk. 3 type—is the great increase in heat transfer area, which means that the power and hence the neutron flux can be considerably increased. (auth)

38671 (WAPD-T-2029) COMPARISON OF THERMAL NEUTRON SPECTRUM MEASUREMENTS AND CALCULATIONS IN LIGHT-WATER-MODERATED URANIUM CELLS. Volpe, J. J. (Bettis Atomic Power Lab., West Mifflin, Pa.). June 1967. Contract AT(11-1)-Gen-14. 29p. (CONF-670707-15). Dep. CFSTI.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich.

A comparison of experimental and theoretical values for the thermal neutron scattering kernel for light water moderated reactors is presented. Measurements utilized the activation technique to sample the thermal neutron spectrum; calculations were made by using the discrete frequency oscillator motions to describe scattering (Nelkin model) with a modification of spatial anisotropy of proton motion (Koppel and Young model) and use of a distributed frequency spectrum for oscillatory motions (Haywood model). All data, both experimental and theoretical, are tabulated to facilitate comparison. (M.L.S.)

38672 (WCAP-3726-1) PuO_2–UO_2 FUELED CRITICAL EXPERIMENTS. Leamer, R. D.; Orr, W. L.; Stover, R. L.; Taylor, E. G.; Tobin, J. P.; Vukmir, A. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). July 1967. Contract AT-(30-1)-3726. 129p. Dep. CFSTI.

A series of critical experiments using mixed-oxide (PuO_2–UO_2) plutonium fuels was carried out at the Westinghouse Reactor Evaluation Center (WREC). Two plutonium fuels with a variation in the ^{240}Pu isotopic content and one low enrichment uranium fuel were used in an experimental program which included buckling, reactivity, and power distribution measurements. Buckling measurements were made in five clean lattices with the 8% ^{240}Pu fuel and two clean lattices with the 24% ^{240}Pu fuel. With the 8% ^{240}Pu fuel, buckling measurements were made in two lattices at two different boron concentrations. The reactivity worths of voids, water holes, and control rods in different test arrays were determined in single and multi-region cores. Water hole and water slot power peaking effects were measured in clean and borated cores. Power distribution measurements were made in cores containing concentric regions of the different fuels, multi-region slab cores, and in cores containing interspersed fuels. (auth)

38673 STUDY OF THE OPTIMUM POSITION OF THE HORIZONTAL NEUTRON BEAMHOLES OF THE SM-2 REACTOR. Tsykanov, V. A.; Kormushkin, Yu. P.; Klimenkova, N. A.; Safonov, V. A.; Klinov, A. V.; Nikol'skii, S. N. At. Energ. (USSR), 22: 411-12(May 1967). (In Russian).

The horizontal canals of the SM-2 reactor were designed to extract neutron beams and to carry out studies requiring reactor neutrons. Three of the canals are located directly against the side surface of the core, while two others approach the core at varying angles at a distance of 50 mm. The space between the bottom of the canals and the core is filled with Be. All of the canals are water cooled. Tests were carried out on the reactor model to determine the optimum location of the beamholes with respect to the side surface of the core, taking into account the influence of water or Be moderator on the count rate; the effect of the nearest shim rod was also examined. A moderator layer between the core and the beam-hole improved the characteristics of the latter: the thermal-neutron flux was strongly increased, the fast-neutron background was reduced, and the effect of the shim rod became less noticeable. (TTT)

38674 APPLICATION OF THE CHERENKOV EFFECT TO THE DETECTION OF FAILED FUEL ELEMENTS IN THE WWR-S REACTOR. Szuta, Marcin; Budzinski, Wladyslaw (Inst. of Nuclear Research, Polish Academy of Sciences, Swierk). Nukleonika, 12: 431-40(1967).

A description of the Cherenkov-effect monitor and its application to the detection of fuel element failure, in general, and to the localization of a particular failed fuel assembly is given. Experiments with a failed fuel element are described. (auth)

38675 DETERMINATION OF NUCLEAR CORE TEMPERATURES WITH HEAT GENERATION VARYING IN LONGITUDINAL DIRECTION. Minashin, V. E.; Sholokhov, A. A.; Gribanov, Yu. I. At. Energ. (USSR), 22: 362-6(May 1967). (In Russian).

A method for the calculation of surface temperature of heat-emitting elements with use of the heat emission coefficient was considered. On actual examples, the errors which are possible during calculation of variable heat generation along the active zone were analyzed. Other methods for the calculation of the temperature of fuel elements during random distribution of the heat generation longitudinally, based on the principle of superposition, were proposed. Practical recommendations on the calculation of the temperature by means of the Dyuamel integrals were given. For illustration of the method, an analysis was made of test data with measurement of the temperature during sinusoidal change of the thermal current along the pipe. (tr-auth)

38676 MULTIPLE SAMPLE IRRADIATOR FOR POOL REACTORS. Kurtz, D. A.; Miller, W. W. (Pennsylvania State Univ., University Park). Nucl. Instrum. Methods, 53: 355-6 (1967).

Multiple samples can be irradiated simultaneously in pool reactors by insertion in a rotating foam plastic disc devised. Data supporting uniform irradiations are presented. (auth)

38677 STUDIES ON CERAMIC FUELS WITH THE USE OF FISSION GAS RELEASE LOOP. III. NEUTRON FLUX MONITORING IN SPECIMEN CHAMBER OF FGRL BY COUNTING ^{16}N GENERATED $^{16}O(n,p)^{16}N$ REACTION IN PRIMARY COOLING WATER. Kamemoto, Yuichiro; Shiba, Koreyuki; Handa, Muneo; Yamagishi, Shigeru; Fukuda, Takeshi; Takahashi, Yoshihisa; Tanifuji, Takaaki; Omori, Shunzo (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 4: 278-82 (June 1967).

Flux monitoring in the specimen chamber of Fission Gas Release Loop (FGRL) was carried out by directly and continuously reading with a γ-ray spectrometer the content of ^{16}N in the primary cooling water produced by $^{16}O(n,p)^{16}N$ reaction within the cooling jacket of FGRL. ^{16}N generation is not influenced by γ-ray build-up in the

reactor nor by the temperature in the specimen chamber. The detector can be simply set outside the pipe through which the cooling water flows, because the high energy γ-rays emitted during the ^{16}N decay easily penetrate the pipe wall. (auth)

38678 ANALOG SIMULATION OF PULSED-NEUTRON EXPERIMENTS AND METHODS OF DIRECT CRITICALITY DETERMINATION. Garlid, Kermit L.; Stenstrom, Dennis G. (Univ. of Washington, Seattle). Trans. Amer. Nucl. Soc., 10: 18-19(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38679 IMPACT OF IRRADIATION-DAMAGE STUDIES ON DESIGN CRITERIA FOR PRESSURE TUBING AND FUEL-ELEMENT CLADDING. Merckx, Kenneth R. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 166(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38680 THE ^{17}N DELAYED-NEUTRON SPECTRUM. Amiel, S. (Soreq Nuclear Research Centre, Yavne, Israel); Cuttler, J.; Notea, A.; Shalev, S. Trans. Amer. Nucl. Soc., 10: 181(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38681 EXPERIMENTS IN THE INTERNAL THERMAL COLUMN OF THE ARGONNE ADVANCED RESEARCH REACTOR CRITICAL FACILITY. Robinson, W. R.; Johnson, T. W.; Plumlee, K. E.; Stanford, G. S. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 182-3(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38682 CALCULATION OF THE SODIUM-VOID EFFECT BY FLUX SYNTHESIS. Travelli, A.; Helm, F. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 275-6(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38683 FISSION RATES IN A ZONED-CORE FAST CRITICAL ASSEMBLY. Ancarani, A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 275(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38684 ANALYSIS OF SMALL-SAMPLE DOPPLER-EFFECT MEASUREMENTS. Lewis, R. A.; Till, C. E. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 274(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38685 VERIFICATION OF DOPPLER MEASUREMENTS IN ZONED FAST CRITICAL ASSEMBLIES. Lewis, R. A.; Till, E. F.; Groh, E. G.; LeSage, L.; Marshall, J. E. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 273-4(June 1967).
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38686 MEASUREMENT OF SPACE-DEPENDENT MATERIAL REACTIVITY WORTHS. Knapp, W. G. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 272-3(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38687 EXPERIMENTAL NEUTRON-SPECTRUM COMPARISON FOR A ZONED AND A HOMOGENEOUS FAST CRITICAL ASSEMBLY. Bennett, E. F. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 271-2(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38688 ZONED-CORE CONCEPTS. Karam, R. A.; LeSage, L. G. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 270-1(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38689 FFTF CRITICAL EXPERIMENTS: CONTROL-ROD STUDIES ON ZPR-3. Long, J. K. (Argonne National Lab., Ill.); Hess, A. L; McVean, R. L.; Persiani, P. J.; Ulrich, A. J.; Baird, Q. L.; Bennett, R. A.; Engstrom, S. L. Trans. Amer. Nucl. Soc., 10: 269-70(June 1967).
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38692 PROMPT-NEUTRON DECAY IN DELAYED-CRITICAL ASSEMBLIES OF THREE INTERACTING CORES. Mihalczo, J. T. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 242(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

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From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

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From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

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From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38696 EXPERIMENTAL RESULTS FROM LARGE-CAVITY REACTOR CRITICAL EXPERIMENT. Hyland, R. E. (Lewis Research Center, Cleveland); Pincock, G. D.; Kunze, J. F.; Wood, R. E. Trans. Amer. Nucl. Soc., 10: 8-9(June 1967).
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38697 FFTF FUEL-ELEMENT DESIGN. Cohn, P. D.; Bailey, W. J.; Lobsinger, R. J.; Millhollen, M. K. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 107-8(June 1967).
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38698 POTENTIAL OF ADVANCED FUELS FOR A FAST TEST REACTOR. Bailey, W. J. (Battelle-Pacific Northwest Lab., Richland, Wash.); Cohn, P. D.; Aase, D. T.; Foote, F. G.; Heck, F. M.; Kittel, J. H.; Last, G. A.; McHugh, W. E.; Strasser, A. A.; Wheelock, C. W. Trans. Amer. Nucl. Soc., 10: 108 (June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38699 FISSION-PRODUCT RELEASE FROM WATER-REACTOR TRANSIENT ACCIDENTS SIMULATED IN TREAT. Lorenz, R. A.; Parker, G. W. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 340(June 1967).
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From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38703 ANALYSIS OF RAPID EXCURSIONS INVOLVING FUEL-ELEMENT RUPTURE. Elbaum, G. J.; Thompson, T. J. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 10: 331-2(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38704 TLD MEASUREMENT OF GAMMA-RAY HEATING IN THE AARR CRITICAL ASSEMBLY. Stanford, G. S.; Johnson, T. W. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 395-6(June 1967).
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From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

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38709 FOIL CORRECTION FACTORS FOR ρ_{28} AND δ_{25} MEASUREMENTS TO ACCOUNT FOR FIRST-FLIGHT FLUX DEPRESSION. Price, L. N.; Driscoll, M. J.; Thompson, T. J.; Kaplan, I. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 10: 198(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

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38711 EXPERIMENTAL AND ANALYTICAL DETERMINATION OF THE REACTIVITY WORTHS OF ^{233}U, ^{235}U, ^{236}U, AND ^{237}Np SAMPLES IN A SERIES OF ^{235}U–GRAPHITE CRITICAL ASSEMBLIES. Bardes, R. G.; Gillette, E. M.; Nirschl, R. J.; Traylor, R. C. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 198-200(June 1967).
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From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38713 TEMPERATURE DEPENDENCE OF NUCLEAR REACTION RATES IN A Pu-H_2O LATTICE. Carver, J. G.; Porter, C. R. (General Electric Co., Pleasanton, Calif.). Trans. Amer. Nucl. Soc., 10: 190(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

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From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

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From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38716 MEASUREMENTS AND ANALYSES OF SOME $^{233}UO_2$–ThO_2 WATER LATTICE EXPERIMENTS. Sehgal, Bal Raj; Windsor, H. H.; Tunney, W. J. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 10: 193-4(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38717 MEASUREMENT OF REACTOR PARAMETERS IN SLIGHTLY ENRICHED URANIUM, HEAVY-WATER-MODERATED MINIATURE LATTICES. Sefchovich, E.; Kaplan, I.; Thompson, T. J. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 10: 194-5(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

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From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

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From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

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38722 EXPERIMENTS AND CALCULATIONS FOR H_2O–MODERATED ASSEMBLIES CONTAINING UO_2–2 WT PERCENT PuO_2 FUEL RODS. Uotinen, V. O.; Williams, L. D. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 186-7(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38723 EXPERIMENTAL INVESTIGATION OF SPATIAL EFFECTS ON THE POWER SPECTRA OF A LARGE REACTOR. Buhl, A. R. (Univ. of Tennessee, Knoxville); Hanauer, S. H.; Baumann, N. P. Trans. Amer. Nucl. Soc., 10: 288-9(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

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38725 ANALYSIS OF CRITICAL-FUEL-SOLUTION REACTORS CONTAINING ARRAYS OF VOID TUBES. Mayo, Wendell (Lewis Research Center, Cleveland). Trans. Amer. Nucl. Soc., 10: 232(June 1967).
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From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38727 THE DEVELOPMENT OF ALUMINUM-BASE Eu_2O_3 CONTROL RODS FOR THE HIGH-FLUX ISOTOPE REACTOR. Beaver, R. J.; Leitten, C. F. Jr.; Adamson, G. M. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 137-8(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38728 DESIGN AND FABRICATION OF A TITANIUM-CLAD TUNGSTEN GAMMA-SHIELD ASSEMBLY. Stein, Ralph (National Aeronautics and Space Administration, Sandusky, Ohio); Gripshover, P. J.; Peterson, J. H. Trans. Amer. Nucl. Soc., 10: 139-40(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38729 UP-RATING THE POWER OF THE GENERAL ELECTRIC TEST REACTOR. Larson, H. J. (General Electric Co., Pleasanton, Calif.). Trans. Amer. Nucl. Soc., 10: 326(June 1967).
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38730 DOPPLER COEFFICIENT TEMPERATURE DEPENDENCE AND THE EFFECT OF SODIUM VOIDING. Till, C. E.; Lewis, R. A.; Pond, R. B. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 335(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38731 ASSEMBLY AND WELDING OF FUEL ELEMENTS FOR THE HIGH-FLUX ISOTOPE REACTOR. Tackett, J. W. (Oak Ridge National Lab., Tenn.); Barker, J. R.; Slaughter, G. M. Trans. Amer. Nucl. Soc., 10: 125(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38732 PRODUCTION OF HIGH-FLUX ISOTOPE REACTOR FUEL ELEMENTS. Adamson, G. M. Jr. (Oak Ridge National Lab., Tenn.); Binns, J.; Knight, R. W. Trans. Amer. Nucl. Soc., 10: 124-5(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38733 PHOTOGRAPHIC STUDIES OF UO_2 PELLET FUEL RODS IN WATER SUBJECTED TO NUCLEAR TRANSIENTS IN TREAT. Harrison, L. J. (Argonne National Lab., Idaho Falls, Idaho); Liimatainen, R. C.; Testa, F. J. Trans. Amer. Nucl. Soc., 10: 127-8(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38734 "AS FOUND" RELIABILITY ANALYSIS OF GETR SAFETY SYSTEMS. Zanot, John R. (General Electric Co., Pleasanton, Calif.). Trans. Amer. Nucl. Soc., 10: 325-6(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38735 DEVICE FOR MODIFYING THE DEGREE OF FILLING OF NUCLEAR ELEMENTS. (to Gesellschaft fuer Kernforschung m.b.H.). French Patent 1,408,448, July 5, 1965. Priority date Aug. 16, 1963, Germany.
A filling machine for filling core elements of research reactors with different kinds of pellets in a predetermined sequence is described. (NPO)

Production Reactors

Refer also to abstracts 36297 and 38593.

38736 (HW-81725) FURTHER EVALUATION OF THE EFFECTIVENESS OF INSPECTION AND CONTROL PROCEDURES. Bennett, C. A.; Granquist, D. P. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Apr. 15, 1964. Contract AT(45-1)-1350. 48p. DTIE.
The applicability and effectiveness of IAEA safeguards under a disarmament agreement for the HAPO complex with several reactors, separation plants, and fuel manufacturing facilities were studied. Difficulties in treating the problem due to changes in composition, amount, and form of the Pu and U are considered. Consequences of diversion, methods of diversion from a reactor, and estimates of diversion potential are discussed. (M.C.G.)

38737 FISSION-PRODUCT RELEASE FROM URANIUM FUEL: FIRST COMPARISON BETWEEN MINIATURE AND MASSIVE SPECIMENS. Reid, D. L. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 340-1(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38738 MULTIPURPOSE REACTOR FUEL CHANNEL MONITORING SYSTEM. Creek, K. O. (General Electric Co., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 327(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

Reactor Components, Fuels and Accessories

Refer also to abstracts 36226, 36228, 36243, 36254–36256, 36420, 36423, 36428, 36433, 36787, 36789, 36809, 36820, 36844, 36901, 36902, and 36914.

38739 (AECL-2688) BURNUP OF CERAMIC FUEL BY γ-RAY SCANNING. Durham, R. W. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Apr. 1967. 14p. (CONF-670401-11). Dep. CFSTI. CAN $0.50.
From 153rd National Meeting, American Chemical Society, Miami Beach, Fla.
A Ge (Li) γ-ray detector has been used to measure the variations in intensity of several fission product γ-rays along the length of UO_2 fuel pins. Although ^{137}Cs was found to be migrating axially at a heat rating of about 40 W/cm it was still possible to determine burnup nondestructively from this nuclide after standardizing the scanning equipment with a fuel pin of known burnup. The ratio of ^{239}Pu to ^{235}U fissions can be predicted from the ratio of ^{106}Ru to ^{137}Cs γ-ray intensities. Axial migration of ^{131}I was found to be high at a heat rating of about 60 W/cm while ^{132}Te and ^{140}Ba did not migrate far. In one instance however, ^{132}Te showed a similar pattern to ^{131}I. An NPD fuel pin displayed no fission product migration and the relative γ-ray intensities of ^{134}Cs, ^{137}Cs and ^{95}Zr were consistent with flux gradient changes occurring during fuel movement through a fuel channel. (auth)

38740 (BNWL-459) ZODIAC(2 +2): A REVISION TO ZODIAC2. Holeman, R. H.; Matsumoto, D. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1967. Contract AT-(45-1)-1830. 10p. Dep. CFSTI.
The addition of the HRG epithermal cross section averaging code as an alternative to GAM in the IBM 7090 burnup chain ZODIAC2 is described. Reorganization and expansion of cross section libraries are explained. Revised input instructions are given. (auth)

38741 (BNWL-CC-511) IRRADIATION TESTING NEEDS AND FACILITIES FOR FAST REACTOR FUEL AND MATERIAL DEVELOPMENT. Goldsmith, S. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1, 1966. Contract AT(45-1)-1830. 54p. Dep. CFSTI.
The irradiation performance information needed to develop fast reactor fuels and materials includes: fuel pin swelling, fission-gas release characteristics, fuel slumping, Pu and fission product migration characteristics, fuel structural changes, fuel-cladding compatibility, failure behavior, transient behavior, fabrication processes and design variables, and mechanical stability of fuel pins and subassemblies. The effects of fast- and thermal-neutron environments on fuel and structural materials are discussed along with irradiation facilities. (M.C.G.)

38742 (EIR-100) I. TWO-DIMENSIONAL MULTIGROUP THEORY WITH ONE THERMAL GROUP AND FLUX-INDEPENDENT CROSS-SECTIONS. Auerbach, T. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). June 1967. 68p. Dep.
Heterogeneous theory in multigroup approximation is applied to finite, reflected, non-uniform lattices, consisting of different types of elements having finite radii. Solutions for the flux are found in cylindrical 2-dimensional geometry, the z-dependence of the flux being accounted for by a single axial buckling. It will be assumed that the flux inside an element can be obtained from a multigroup P_N-calculation. The moderator flux is determined in lattice geometry by use of asymptotic P_N-theory, i.e., that part of the P_N-solution which survives at distances of a few mean free paths from the actual surface of a lattice element. The asymptotic part of the P_N-flux inside a channel, and the heterogeneous flux outside, are matched at the channel surface. A similar approach is used to assure continuity of flux and current across the moderator-to-reflector interface. In view of the change in energy dependence of the flux across the lattice, scattering, absorption, and production in each element will change as a function of channel location. By satisfying the boundary conditions of flux and current continuity this change is accounted for in a consistent manner as long as lattice elements respond linearly to spectrum changes, i.e., as long as macroscopic cross-sections are flux independent. There will be no need for defining cells or replacing elements by equivalent extrapolation lengths. The theory is in modular form. Module 1 consists of the preparation of input data by means of P_N-theory; module 2 consists of the heterogeneous calculation. (auth)

38743 (EIR-111) ARLEKIN: A GENERALISED REACTOR KINETICS CODE USING LIE-SERIES. Mayor, J. C.; Mennig, J.; Sarlos, G. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). May 1967. 17p. Dep.

A reactor kinetics code based on a method of integration which makes use of LIE-series and permits reliable error control by specifying appropriate input parameters is described. (J.C.W.)

38744 (K-DP-2403) COMPUTER MODELS FOR USAEC OPERATIONAL PLANNING. Van Wie, N. H. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). Aug. 22, 1967. Contract W-7405-eng-26. 33p. (CONF-670815-1). Dep. CFSTI.

From 14th International Meeting of The Institute of Management Sciences, Mexico City, Mex.

Digital computer models of facilities within the U. S. Atomic Energy Commission have been implemented to aid in the planning function of management. These models have evolved into three function classes: situation models to replicate past or future events in a system, given all decisions; combinatorial models that aggregate several contiguous facilities into a larger system, adjusting inputs and outputs for facility interdependence, and ranking alternative choices; and optimizing models that identify optimal decisions according to stated objectives. Use of computer models by the USAEC and its operating contractors as a tool for both short- and long-range planning is discussed, as well as the direction that modeling is expected to take in the future. (auth)

38745 (NYO-3738-7) WIDE RANGE DIGITAL NUCLEAR INSTRUMENTATION CHANNEL: PHASE I STUDY. Schultz, M. A.; Matty, T.; Kenney, E. (Milletron, Inc., Pittsburgh, Pa.). May 30, 1967. Contract AT(30-1)-3738. 97p. Dep. CFSTI.

The results of the Phase I study program undertaken in conjunction with the ultimate design, construction, and evaluation of a wide range digital reactor measurement channel are presented. The system will monitor and display reactor power levels as well as the rate-of-change of the power level. (B.G.D.)

38746 INFLUENCE OF OPERATING ENVIRONMENT AND PROCEDURES ON MATERIAL BEHAVIOR: RADIATION EFFECTS AND OPERATION TO MINIMIZE THE INFLUENCE OF THESE EFFECTS. Steele, L. E. (Atomic Energy Commission, Washington, D. C.); Knighton, G. W.; Potapovs, U. Trans. Amer. Nucl. Soc., 10: 151-2(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38747 BRITTLE-FRACTURE DESIGN CONCEPTS: TRANSITION TEMPERATURE APPROACH. Miller, Edward C. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 10: 152-3(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38748 BRITTLE-FRACTURE DESIGN CONCEPTS: FRACTURE MECHANICS APPROACH. Randall, Pryor N. (TRW Systems, Redondo Beach, Calif.). Trans. Amer. Nucl. Soc., 10: 153-4(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38749 MATERIAL FACTORS AFFECTING FRACTURE TOUGHNESS. Hodge, John M. (United States Steel Corp., Monroeville, Pa.). Trans. Amer. Nucl. Soc., 10: 147-8(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38750 INFLUENCE OF OPERATING ENVIRONMENT AND PROCEDURES ON MATERIAL BEHAVIOR: EFFECTS OF COUPLING NUCLEAR RADIATION WITH STATIC AND CYCLIC SERVICE STRESSES AND OF PERIODIC PROOF TESTING. Hawthorne, J. R.; Loss, F. J. (Naval Research Lab., Washington, D. C.). Trans. Amer. Nucl. Soc., 10: 149-50(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38751 PHOENIX FUEL FOR TEST REACTORS. Busselman, G. J. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 371-2(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38752 WVI-WESTINGHOUSE VIBRATION CORRELATION FOR MAXIMUM FUEL-ELEMENT DISPLACEMENT IN PARALLEL TURBULENT FLOW. Reavis, J. R. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 10: 369-71 (June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38753 CHEMICAL METHOD TO DETERMINE THE FAST-NEUTRON FRACTION OF THE DOSE RATE IN A NUCLEAR REACTOR. Holroyd, R. A.; Golliher, K. G.; Thiele, A. W. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 10: 54-5(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38754 PREPARATION OF PLUTONIA-URANIA FUELS OF LOW OXYGEN-TO-METAL RATIO. Aitken, E. A. (General Electric Co., San Jose, Calif.); Craig, C. N. Trans. Amer. Nucl. Soc., 10: 99(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38755 AN ELECTRICAL PROBE FOR CHECKING HOMOGENEITY IN MIXED-OXIDE FUEL PELLETS. Evans, S. K.; Lyon, W. L. (General Electric Co., Pleasanton, Calif.). Trans. Amer. Nucl. Soc., 10: 99-100(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38756 EFFECTS OF CONTAINMENT SYSTEM SIZE ON FISSION-PRODUCT BEHAVIOR. Watson, G. M. (Oak Ridge National Lab., Tenn.); Perez, R. B.; Fontana, M. H. Trans. Amer. Nucl. Soc., 10: 339-40(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38757 TWO-DIMENSIONAL TURBULENT-FLOW MIXING MODEL FOR PARALLEL-FLOW ROD BUNDLES. Lowe, Phillip A. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 10: 363-4(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38758 PHASE RELATIONS IN THE HIGH-CARBON PORTION OF THE U–Pu–C SYSTEM. Reavis, J. G.; Shupe, M. W.; Bjorklund, C. W.; Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 10: 111-12(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38759 THE ROLE OF FISSION PRODUCTS IN THE SWELLING OF IRRADIATED UO_2 AND $(U,Pu)O_2$ FUELS. Anselin, F. (Commissariat a l'Energie Atomique, Paris); Baily, W. E. Trans. Amer. Nucl. Soc., 10: 103-4(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38760 CRITICALITY OF PLUTONIUM COMPOUNDS IN THE UNDERMODERATED RANGE, $H:Pu \leq 20$. Hansen, L. E.; Clayton, E. D. (Battelle-Pacific Northwest Lab., Richland, Wash.). Trans. Amer. Nucl. Soc., 10: 307-8(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38761 EFFECTIVENESS OF CONTROL-ROD MATERIALS. Iskenderian, H. P. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 10: 189(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38762 FRACTURE OF TUBULAR FUEL CLADDING DUE TO PLASTIC INSTABILITY. O'Donnell, W. J. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 10: 163-4(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38763 FABRICATION OF FUEL RODS CONTAINING PELLETIZED ^{233}U-OXIDE FUELS. Fischer, R. L.; Frankhouser, W. L.; Crain, H. H.; Suidan, J. H.; Eyler, J. H.; Speer, E. L. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 10: 123(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38764 DEVELOPMENT OF ZrH_x AND $ZrH_x \cdot UO_2$ POROUS BODIES FOR HYDROGEN REACTIVITY CONTROL EXPERIMENT. Strazza, Neal P. (Martin Marietta Corp., Baltimore). Trans. Amer. Nucl. Soc., 10: 126(June 1967).

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38765 ANALYTICAL AND EXPERIMENTAL DETERMINATION OF TIME-DEPENDENT DEFORMATIONS OF PRESTRESSED CONCRETE REACTOR VESSELS. Rashid, Y. R.; Ople, F. S.

Jr. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 10: 322(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38766 ACOUSTICAL FATIGUE LIFE STUDY IN COMPONENTS OF NUCLEAR REACTORS. Fenech, Henri (Massachusetts Inst. of Tech., Cambridge); Hunt, Paul S.; Rim, Chang Saeng. Trans. Amer. Nucl. Soc., 10: 323-4(June 1967).
From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif., June 11–15, 1967. See CONF-670602.

38767 NEW CONTAINMENT DESIGN LOWERS NUCLEAR PLANT CAPITAL COSTS. Westinghouse Eng., 27: 82-3(May 1967).
A new concept in nuclear generator design is described which will drastically reduce the size of a nuclear plant containment structure. It depends on the use of an ice bed to serve as a heat absorber in the event of accidental release of steam within the containment structure. Its advantages are: a smaller containment structure, design for lower pressures, with resultant reduction in capital costs; rapid absorption of heat; and a virtually static system, which contributes to reliability. Rupture of the reactor coolant loop piping or other element, with the sudden release of large quantities of steam, which must be held within the containment structure, has heretofore been safeguarded against by a silo-shaped or spherical structure, designed with sufficient volume and strength to hold the quantity of steam that might be released. In the new design the ice is used as a condenser system to condense swiftly and safely any steam accidentally released within the containment structure. This new ice condenser reactor containment system involves the use of a cold storage compartment surrounding the nuclear steam supply system. Tests have demonstrated the effectiveness of this new containment concept and have confirmed engineering estimates of the performance. The ice condenser performs equally well over a wide range of conditions, including a variety of ice configurations and steam blowdown times ranging from 10 sec to 45 min. (BBB)

38768 THE COMPUTER: NEGLECTED TOOL OF THE MATERIALS SPECIALIST. Merckx, Kenneth R. (Battelle Memorial Inst., Richland, Wash.). Nucleonics, 25: 67-71 (June 1967).
Computer uses in reactor design are discussed. Computers can aid the materials specialists by serving as data libraries and as guides to needed experiments. The role computers can play in implementing the contributions from materials specialists into fuel-element design procedures is emphasized. Examples such as the NUKER code and CYGRO subroutine are used as illustrations. (J.R.D.)

38769 RECOIL OF FISSION PRODUCTS IN HOMOGENEOUS CARBON STRUCTURES. Evans III, R. B.; Rutherford, J. L. (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 38: 3127-34 (July 1967). (ORNL-P-2839).
An experimental investigation of the average range of fission fragments in pyrolytic graphite was performed by exposing coupons of this material bearing a thin electromagnetically deposited layer of ^{235}U to thermal neutrons. For the experiments, reliable and reproducible sectioning techniques were developed for the determination of ranges in thick targets with variable structure. The procedures used to obtain the range average in terms of the experimental data are described in detail, and an empirical formula for the calculation of ranges in pyrocarbons is given. Analytical expressions were generated for describing the penetration of the recoil-fission fragments in the target material and evaluating various theoretical models of electronic and nuclear-stopping mechanisms in a reference structure. It was found that for carbons of homogeneous structure and with void sizes smaller than Bohr's straggling parameter, the penetration curves could be obtained as convolutions of a kernel of the form of a normal-distribution curve. For the thin extended sources used in this investigation, the various integrations performed mitigate straggling effects so that the only important parameter for data correlations is the average range, which was obtained for four mass chains in six different experiments. The values so obtained compared favorably with Lindhard's and Frank's microscopic models for the calculation of the average range in carbon. (auth)

38770 CHANNEL TUBE ASSEMBLIES. Bradley, N. (United Kingdom Atomic Energy Authority, Risley, Eng.); Connor, F. P.; Edwards, H. K.; Perrin, A. J. pp 13-29 of Some Engineering Aspects of the Winfrith Steam Generating Heavy Water Reactor. Proceedings of a Symposium held in London, May 18, 1967. London, Institution of Mechanical Engineers, 1967.
See CONF-670539.
The reactor core contains 112 vertical channel tube assemblies, each a composite stainless steel and Zr tube, 5 in. bore by 30 ft. long. The refuelling seal plug consists of the seal unit, the latching mechanism, and the grab handling mechanism. An account is given of the design problems encountered and of the development, redesign, and tests which were necessary. Specific problems included the Zr to steel joints on the tubes, the seal unit design, and the choice of hard-facing materials for the seal. The design and supply management logic applied to the channel assembly is explained as an illustrative example in relation to the paper on the overall project management. (UK)

38771 MAGNESIUM ALLOYS WITH IMPROVED CREEP RESISTANCE. (to Magnesium Elektron Ltd.). French Patent 1,363,990. May 11, 1964. Priority date Apr. 29, 1962, Great Britain.
A Mg alloy for fuel element cans consisting of Mg, 0.5 to 1.5% Al, 0.5 to 1.5% Mn, 0 to 0.02% Be, 0 to 0.5% rare earths, and 0 to 0.5% Zn is described. (NPO)

38772 FUEL ELEMENT FOR NUCLEAR REACTOR. (to General Dynamics Corp.). French Patent 1,297,351. May 21, 1962. Priority date June 8, 1960, United States.
A fuel element with a reduced tendency to elongate irreversibly consists of a cylindrical U–Zr–H fuel core that is tapered inwardly at both ends, enclosed in an Al jacket. The surface of the fuel core is polished and a lubricant, e.g., colloidal graphite, is introduced between core and jacket. (NPO)

38773 IMPROVEMENTS IN NUCLEAR REACTORS. (to Hawker Siddely Nuclear Power Comp. Ltd.). French Patent 1,215,447. Jan. 15, 1962. Priority date Mar. 17, 1959, Germany.
A cylindrical fuel element, provided with an axial cavity at the bottom of which is placed a capsule, filled with Hg or a 90% Hg–10% Cd alloy and closed with a rupture disk is described. When during reactor operation the temperature of the fuel element surpasses an upper limit the disk will break, liberating the Hg or Hg–Cd into the cavity and thus reducing the reactivity. The fuel element is further provided with an electrical indicating apparatus which allows control whether the capsule is broken or not. (NPO)

38774 IMPROVEMENTS IN NUCLEAR REACTOR FUEL ELEMENTS. (to Soc. An. d'Etudes et Realisations Nucleaires Sodern). French Patent 1,238,281. Mar. 5, 1962. Filed May 18, 1960.
A tube, consisting of sintered Al_2O_3 monocrystals, is used as a jacket for a fuel element. The material is highly transparent for neutrons and infrared radiation and allows operating temperatures above 1000°C. In a preferred embodiment of the fuel element the jacket is closed at both ends and filled with a pressurized noble gas which counteracts the escape of fission gases from the fuel core. (NPO)

38775 FUEL ELEMENT FOR NUCLEAR REACTORS. (to Kernreaktor Bau- und Betriebsgesellschaft m.b.H.). French Patent 1,432,520. Feb. 14, 1966. Priority date Nov. 2, 1962, Germany.
The fuel element is constituted by a jacketed, thick-walled, hollow cylinder, presenting radial, conical apertures in which compacted fuel is introduced. The cylinder may further be provided with a helical groove connecting the apertures for the evacuation of fission gases. (NPO)

38776 FLEXIBLE CAN FOR NUCLEAR FUEL. (to General Electric Co.). French Patent 1,383,261. Nov. 16, 1964. Priority date Dec. 26, 1962, United States.
The fuel rod is provided with a thin can, which presents longitudinal, U-shaped folds that are equidistantly distributed around the periphery of the element. These folds allow radial deformation of the can in response to variations in the coolant pressure or to differential dilations while a good contact between fuel and can is maintained. All folds may be directed outwardly or outward folds may alternate with inward folds, the latter ones thereby contacting grooves in the fuel body. (NPO)

38777 MULTI-REGIONED FUEL ELEMENT. (to U.S. Atomic Energy Commission). French Patent 1,424,101. Nov. 29, 1965. Priority date Feb. 7, 1964, United States.
Bar shaped and tubular ceramic fuel elements are described. In order to reduce the central temperature the fuel core is subdivided into regions of different enrichment, the fuel regions adjacent to the coolant presenting a high degree of enrichment (e.g., about 3%) and the thicker central fuel region presenting a low degree of enrichment (e.g., 0.2%). (NPO)

38778 FUEL ELEMENTS FOR NUCLEAR REACTORS. (to Deutsche Gold- und Silber-Scheidenstalt). French Patent 1,215,673. Nov. 23, 1959. Priority date Oct. 16, 1957, Germany.
The application of a corrosion resistant and heat conductive interlayer between the ceramic fuel core and the metal jacket

of a fuel element is presented. The interlayer may consist of a metal (Fe, Ni, Be, Si, Zn, Cr, Al, Ti, V, Zr, Nb, Mo), of a carbide (e.g., SiC), a U silicide or of a mixture of these. (NPO)

38779 FUEL ELEMENT FOR NUCLEAR REACTORS AND METHOD FOR ITS MANUFACTURE. (to Kernreaktor Bau-und Betriebsgesellschaft m.b.H.). French Patent 1,379,176. Oct. 12, 1964. Priority date Dec. 11, 1962, Germany.

A ceramic fuel core is successively plated with different metals, e.g., first with Mo and then with Ni. (NPO)

38780 FUEL ELEMENTS FOR NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,424,095. Nov. 29, 1965. Priority date Feb. 6, 1964, Great Britain.

A fuel element consisting of a U rod in a Magnox jacket is described. To prevent Pu diffusion through the jacket an interlayer, consisting of Al, Al–Si, Cu, Ni, Ag or Pt is applied between rod and jacket, after which heat and pressure is applied to provoke diffusion of the interlayer into the jacket. (NPO)

38781 IMPROVEMENTS IN FUEL ELEMENTS FOR NUCLEAR REACTORS. (to Rolls-Royce Ltd.). French Patent 1,268,652. June 26, 1961. Priority date July 10, 1959, Great Britain.

The fuel element consists of a pile of cylindrical fuel pellets in a thin stainless steel jacket, the pellets being truncated and the jacket being pressed in the grooves between adjacent pellets. (NPO)

38782 IMPROVED TUBULAR FUEL ELEMENT FOR NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). French Patent 1,385,406. Dec. 7, 1964. Filed Sept. 3, 1963.

A tubular fuel element, in which the exterior contact coefficient H_e is superior to the interior contact coefficient H_i, H being defined by $H = (\varphi/T - t)$ (φ = neutron flux at the fuel/jacket interface, $T - t$ = temperature drop at the fuel/jacket interface), is described. This difference between H_e and H_i is stated to increase the specific power and to improve aerodynamic conditions. The difference can be effected by elimination of oxide surface layers at the exterior interface, interposing a metal (Ni, Cr, Alphax, Mg) interlayer at the exterior interface, providing the exterior jacket with protuberances which fit into grooves in the fuel core, and interposing a thermally insulating interlayer, e.g., an oxide, at the interior interface. (NPO)

38783 FUEL ELEMENT FOR NUCLEAR REACTOR. (to Licentia Patent-Verwaltungs-G.m.b.H.). French Patent 1,325,481. Mar. 18, 1963. Priority date June 19, 1961, Germany.

A tubular fuel element which is exteriorly cooled with water and interiorly with steam is described. To prevent excessive temperatures of the jacket at the steam side, a thermally insulating interlayer (Al_2O_3, MgO) is applied at this side between the fuel and the jacket. (NPO)

38784 IMPROVEMENT IN FUEL ELEMENTS FOR NUCLEAR REACTORS. (to CEA). French Patent 1,383,796. Nov. 23, 1964. Filed Sept. 3, 1963.

The heat transfer from a fuel element is improved by providing the fuel core with peripheral grooves and inserting in the grooves metal elements that have a better thermal conductivity than the fuel, with the elements being in good thermal contact with the jacket. The elements may form an integral part of the jacket, form a part of a separate interlayer, e.g., a diffusion barrier, or separate units. (NPO)

38785 NUCLEAR FUEL ELEMENT. (to Nuclear Materials and Equipment Corp.). French Patent 1,303,678. Aug. 6, 1962. Priority date Aug. 23, 1960, United States.

The fuel element consists of a compacted mass of coated fuel particles in a cladding tube. The fuel particles are coated with one or more of the following materials: Al, Cu, Ni, Fe, Si, Cr, Nb, V, W, Mo, Zr, Ti, Mg, Be, C, V–Nb, Mo–W, Mg–Be, Fe–Cr, SS, Al_2O_3, ZrO_2, SiC, BeO and loaded into a Zr, Nb or SS tube; the compacting is effected by swaging or extruding the filled tube. (NPO)

38786 IMPROVED FUEL ELEMENTS FOR NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,374,857. Aug. 31, 1964. Priority date Nov. 19, 1962, Great Britain.

Pu diffusion through Magnox sheaths is prevented by coating the interior surfaces of the sheaths and end caps with graphite or $MgCrO_4$. (NPO)

38787 NUCLEAR FUEL ELEMENT. (to Commissariat a l'Energie Atomique). French Patent 1,412,545. Aug. 23, 1965. Filed Aug. 20, 1964.

The diffusion of Pu through a Magnox can is prevented by application of a duplex can, exteriorly consisting of Magnox and interiorly of one of the following alloys: Mg–2% Al, Mg–2% Al–0.02% Be, Mg–0.7% Al–0.02 Si; Mg–0.7% Al–0.02% Si–1% Ce, Mg–0.7% Al–0.02% Si–1% Ce–0.03% Be. The inner can, the thickness of which is 0.1 to 0.5 of the total thickness, prevents Pu diffusion by formation of intermetallic compounds. The duplex can is manufactured by coextrusion. (NPO)

38788 IMPROVEMENTS IN FINNED HEAT EXCHANGE TUBES. Peyron, A. F. R. French Patent 1,364,085. May 11, 1964. Filed May 8, 1963.

A fuel element can with helical fins, the inclination of the fins in successive axial sections being different, is described. This variation may be accompanied by a variation in fin thickness and distance between fins. (NPO)

38789 HOLLOW FUEL CONTAINING GRAPHITE SPHERE FOR NUCLEAR REACTORS. (to Stadt Dusseldorf). French Patent 1,364,205. May 11, 1964. Priority date May 30, 1962, Germany.

A spherical fuel element, consisting of a graphite sphere in an interior cavity of which nuclear fuel is applied, is described. To prevent the escape of fission gases, the surface of the cavity is coated with a 0.1 to 0.01 mm layer of Pt. The layer may be perforated to prevent excessive pressure build-up in the fuel element which might cause rupture. (NPO)

38790 FUEL ELEMENT. (to CEA). French Patent 1,409,402. July 19, 1965. Filed July 16, 1964.

An assembly of 12 flat or lenticular fuel plates in a supporting tube, six of them forming a hexagonal prism inside the tube while the others are disposed in the median planes of the prism is presented. Adjoining plates are connected to each other. This construction is said to have a greater stability than the well-known assembly of parallel plates. (NPO)

38791 FUEL ELEMENT FOR NEUTRONIC REACTORS AND ITS METHOD OF MANUFACTURE. (to U.S. Atomic Energy Commission). French Patent 1,267,184. June 12, 1961. Priority date May 13, 1959, United States.

A composite fuel pellet, provided with a barrier zone against migration of fission products, the barrier zone comprising a plurality of successive ZrC regions separated from each other by interposed Zr zones, is described. In a first embodiment a fuel-carbon compact is first clad with Zr and then with graphite; subjecting this assembly to a carburizing temperature results in the formation of two ZrC layers separated by residual Zr. In a second embodiment a fuel compact is successively clad with graphite, Zr, and again with graphite and likewise subjected to a carburizing temperature. Instead of Zr an eutectic Zr–Nb alloy may be applied. (NPO)

38792 IMPROVED FUEL ELEMENTS CONSISTING OF METALLIC URANIUM OR ITS ALLOYS, CLAD WITH MAGNESIUM OR ZIRCONIUM ALLOYS. (to SNAM, S.p.A). French Patent 1,417,576. Oct. 4, 1965. Priority date Dec. 16, 1963, Italy.

A Ti interlayer is interposed between a U fuel core and a Mg or Zn jacket, followed by a heat treatment to cause the Ti to diffuse into the core as well as into the jacket. Perfect bonding of the core to the jacket is thus assured. (NPO)

38793 IMPROVEMENTS IN NUCLEAR REACTORS. (to Soc. Francaise des Constructions Babcock and Wilcox). French Patent 1,316,633. Dec. 26, 1962. Filed Dec. 20, 1961.

Cooling of fuel elements is improved by subdividing the contacting gaseous coolant in capillary streams. Two methods for achieving this aim are described. In the first, the fuel element consists of porous ceramic fuel pellets between an inner and an outer perforated tube. The coolant passes radially through the pellets. In the second, a fuel rod with radial fins is provided with a number of longitudinal gas distribution channels contacting the fins over a small part of their periphery and communicating with a central inlet. The coolant gas introduced through the inlet is distributed by the channels between the fins. (NPO)

38794 FUEL ELEMENT CAN. (to Babcock and Wilcox Ltd.). French Patent 1,289,282. Feb. 19, 1962. Priority date May 17, 1960, Great Britain.

The exterior wall of a cylindrical fuel element can is divided in longitudinal sections, each section being provided with helical fins and the helices of adjacent sections being wound in opposite directions so that continuous zigzag channels are formed around the periphery of the can. (NPO)

38795 FUEL ELEMENTS FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,420,289. Oct. 25, 1965. Priority date Jan. 14, 1964, Great Britain.

Cylindrical fuel elements with helical fins or with fins in a herringbone pattern are described. To improve their rigidity when exposed to a pressurized reactor coolant, the planes of the fins are not perpendicular to the surface of the element, the angle with the longitudinal axis being 25–30°. (NPO)

38796 METHOD OF MANUFACTURING FUEL ELEMENTS FOR NUCLEAR REACTORS. (to CEA). French Patent 1,430,350. Jan. 24, 1966. Filed Jan. 21, 1965.

Spherical fuel elements are manufactured by molding a mixture of enriched UO_2 powder, a liquid binder and graphite powder into a sphere, impregnating the sphere with cracked hydrocarbon gases at 900°C during 100 hr, coating the sphere with a mixture of graphite powder and a liquid binder, impregnating the coating with cracked hydrocarbon gas at 900°C during 300 hr, inserting the composite sphere in the central cavity of a graphite sphere, and closing the cavity. (NPO)

38797 FUEL ELEMENT CAN. (to Commissariat a l'Energie Atomique). French Patent 1,405,324. May 31, 1965. Filed May 26, 1964.

The Mg–Zr alloy can (0.1 to 0.7% Zr) is provided on its interior surface with a 0.1 to 25 μ layer of MgO, $MgCO_3$ and C by heating the can in CO_2. The composite layer prevents the outward diffusion of Pu through the can. (NPO)

38798 METHOD FOR EVACUATING AIR FROM A CANNED FUEL ELEMENT DURING ITS MANUFACTURE. (to CEA). French Patent 1,400,493. Apr. 20, 1965. Filed Apr. 14, 1964.

The method for removing air from the interior of a canned fuel rod consists in providing one of the end plugs with a narrow axial bore that communicates with a radial groove in the bottom surface of the plug, evacuating entrapped air through the bore, closing the bore in vacuum with a peg and brazing the peg. (NPO)

38799 ENCAPSULATED NUCLEAR ELEMENT, ITS METHOD OF MANUFACTURE AND APPARATUS FOR CARRYING OUT THIS METHOD. (to Air Reduction Co. Inc.). French Patent 1,330,985. May 20, 1963. Priority date June 30, 1961, United States.

A compacting method for manufacturing fuel spheres, consisting of a core of a dispersion of nuclear fuel in graphite and a graphite jacket is presented. (NPO)

38800 COMPARTMENTED FUEL ELEMENT FOR NUCLEAR REACTORS. (to U.S. Atomic Energy Commission). French Patent 1,429,790. Jan. 17, 1966. Priority date Apr. 13, 1964, United States.

The ceramic fuel pellets in a fuel rod are mutually separated by (perforated) convex disks which contact the can. (NPO)

38801 NUCLEAR FUEL ELEMENT AND ITS METHOD OF MANUFACTURE. (to EURATOM). French Patent 1,362,238. Apr. 20, 1964. Priority date July 4, 1962, Belgium.

The fuel pin element consists of a cylindrical graphite body which contains one or more longitudinal U–carbide pins. This fuel element is to be used in an organic cooled reactor at such an operating temperature that the fuel is molten. Dimensions for obtaining the right operating conditions are given. (NPO)

38802 IMPROVEMENT IN FUEL ELEMENTS. (to CEA). French Patent 1,394,190. Feb. 22, 1965. Filed Feb. 18, 1964.

The fastening of spacer grids in fuel pin assemblies by means of longitudinally split support tubes which are inserted in tangential holes in the graphite sleeve is described. (NPO)

38803 FUEL ELEMENT. (to CEA). French Patent 1,394,189. Feb. 22, 1965. Filed Feb. 18, 1964.

A spacer grid is fastened in a fuel pin assembly by means of centering studs, which are inserted in radial apertures in the graphite sleeve, an encircling strip being provided that exerts a radial pressure on the studs. Plate springs may be provided between the studs and the grid to damp vibrations. (NPO)

38804 FUEL ELEMENTS FOR NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,400,149. Apr. 12, 1965. Priority date July 4, 1963, Great Britain.

A cylindrical fuel element with helical cooling fins and longitudinal splitters is described. To improve the mixing of the coolant the element is provided with helical deflector blades in the spacer between adjacent splitters. The blades are set perpendicular to the cooling fins, contacting their outer edges; in an outward direction the blades stretch as far as the splitters. (NPO)

38805 NUCLEAR REACTOR. (to Gesellschaft fuer Kernforschung m.b.H.). French Patent 1,432,836. Feb. 14, 1966. Priority date Feb. 25, 1964, Germany.

A box-shaped structure for the support of nuclear fuel elements in a reactor vessel is described. The structure is provided with a number of aligned upper and lower central openings, each of which communicates by means of slits with a number of bores surrounding said openings. A number of fuel elements, provided with a special designed support head, is inserted one after another through a central opening, shifted along one or more slits and suspended with their heads in the bores. (NPO)

38806 NEW FUEL ELEMENT WITH INTERIOR REINFORCEMENT AND ITS METHOD OF MANUFACTURE. (to CEA). French Patent 1,375,080. Sept. 7, 1964. Filed July 11, 1963.

A fuel rod, consisting of a tube of pure or slightly alloyed U that is closed at both ends and enclosed in a jacket is described. The fuel rod is reinforced with a second tube contacting the interior wall of the first tube, the second tube being made of a metal with a low neutron capture cross section and with metallurgical properties that do not alter with the temperature, e.g., a U–10% Mo alloy. The axial cavity may be filled with an inert refractory material (Al_2O_3, ZrO_2). (NPO)

38807 IMPROVEMENTS IN ELEMENTS FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,367,328. June 8, 1964. Priority date Aug. 27, 1962, Great Britain.

The collapse of thin-canned fuel elements during operation is prevented by filling the interior free space with a pressurized gas, consisting of 60 parts Ar and 40 parts He. (NPO)

38808 IMPROVEMENTS IN FUEL ELEMENTS FOR NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,426,494. Dec. 20, 1965. Priority date Feb. 24, 1964, Great Britain.

A stainless steel of 16.5 to 17.5% Cr, 13.0 to 14.0% Ni, 2.0 to 2.75% Mo, 1.5 to 2.0% Mn, 0.15% V, less than 0.06% C, 0.8% Si, 0.020% P, 0.020% S, 0.06% N, 0.035% As, 0.020% Sn, remainder Fe, and its C content being at least 0.03%, is described. The steel is useful as jacket material for fuel elements or as matrix material in dispersion or cermet fuels. (NPO)

38809 FUEL ELEMENT CONTAINING A BURNABLE POISON. (to Reactor Centrum Nederland). French Patent 1,425,012. Dec. 6, 1965. Priority date Feb. 21, 1964, Netherlands.

A fuel rod in which burnable poison disks are interspersed between the fuel pellets is described. The disks consist of a dispersion of a burnable poison powder (grain size 150 to 200 μ) in a matrix (Zr, SS, C, Al_2O_3, SiO_2). The powder distribution in the matrix can be nonuniform and/or the disks can be perforated. If the disks are made magnetic their removal during subsequent reprocessing is facilitated. (NPO)

38810 IMPROVEMENTS IN FUEL ELEMENTS FOR NUCLEAR REACTORS. (to Nuclear Power Plant Comp. Ltd. A.E.S.-John Thompson Nuclear Energy Comp. Ltd.). French Patent 1,353,173. Jan. 13, 1964. Priority date Feb. 26, 1962, Great Britain.

A cylindrical fuel element with helical cooling fins and longitudinal splitters which stretch beyond the outer edges of the fins is described. To prevent deformation of the splitters due to local pressure differences in the coolant the splitters do not contact the wall of the coolant channel except at those points where the splitters are mutually joined by braces. (NPO)

38811 REINFORCED FUEL ELEMENT FOR NUCLEAR REACTOR. (to CEA). French Patent 1,370,147. July 15, 1964. Filed July 11, 1963.

A fuel rod, comprising a tube of fissile material that is closed at both ends and enclosed in a jacket, is reinforced by insertion of a block of expanded refractory material in the interior cavity. Suitable materials are ZrO_2 or Al_2O_3 foam, having 4 to 15% or 5 to 20% respectively of the theoretical density. (NPO)

38812 IMPROVED FUEL ELEMENT FOR NUCLEAR REACTOR. (to CEA). French Patent 1,375,079. Sept. 7, 1964. Filed July 11, 1963.

A fuel rod, comprising a tubular fissile core that is closed at both ends and enclosed in a jacket, is provided with interior mechanical reinforcement means that are capable of resisting the external pressure, exerted on the fuel rod by the coolant gas. Five embodiments are described. (NPO)

38813 PRESSURIZED FUEL ELEMENT FOR NUCLEAR REACTOR AND ITS METHOD OF MANUFACTURE. (to CEA). French Patent 1,370,146. July 15, 1964. Filed July 11, 1963.

A fuel rod, comprising a tubular fissile core that is closed at both ends and enclosed in a jacket, is made to resist the external pressure exerted by the reactor coolant gas by filling the interior cavity with pressurized He or Ar either directly or by insertion of a thin-walled, gas-filled container. (NPO)

GENERAL

38814 (BNL-11584) FORTRAN FOR BROOKHAVEN'S CDC 6600 COMPUTER. Fuchel, Kurt; Heller, Sidney (Brookhaven National Lab., Upton, N. Y.). July 1967. 138p. Dep. CFSTI.

A description of the FORTRAN language for the CDC 6600 computer at BNL is given. This computer is running under the SCOPE 2.0 operating system. (R.C.M.)

38815 (BNWL-293) PACIFIC NORTHWEST LABORATORY MONTHLY ACTIVITIES REPORT, JUNE 1966 ON AEC DIVISION OF BIOLOGY AND MEDICINE PROGRAMS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1966. Contract AT(45-1)-1830. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

RATS — effects of sodium taurocholate on intestines of, comparison of, to radiation effects
CERIUM-144 — uptake by fetuses of rats, cross-placental
CESIUM-137 — uptake by fetuses of rats, cross-placental
IODINE-131 — uptake by thyroid gland of rats, effects of age on
ZINC-65 — uptake and distribution in shore crab H. oregonensis, use of autoradiography for determination of
ZINC-65 — accumulation in tissues of freshwater mussel Anodonta, effects of temperature on
SWINE — radiation effects on, pathological β
SWINE — preservation of cadavers of miniature, development of, methods for
SWINE — anesthesia in, testing of electroinduced
PLUTONIUM-239 — uptake by inhalation in dogs, pathological effects of
BLOOD — radiation effects on, content of taurine in urine of man
THORIUM-230 — decay in dogs, rate of
URANIUM-238 — decay in dogs, rate of
POLONIUM-210 — decay in dogs, rate of
DOGS — uranium inhalation by, pathological effects of
SWINE — plutonium-238 retention by gastrointestinal tract of
DOGS — particle clearance from lungs of, kinetics of large
TRYPTOPHAN — transport during synthesis of proteins, mechanism for
FREE RADICALS — radioinduced, in aqueous solutions of amino acids and aromatic nitroso compounds, electron spin resonance of
MAN — cesium-137 content in, in Alaska
BIRDS — ecology at Hanford reservation
IODINE-131 — analysis of
MOLLUSKS — zinc-65 in limpet, biological half life of
ZINC-65 — half life of, in fish in Columbia River, determination of
ZINC-65 — content in adult caddis flies collected along Columbia River
PARTICLES — flow rate in tubes, rate of
GENERATORS — design of spinning disc aerosol
HYDROCHLORIC ACID — transport in atmosphere, measurement of
COMPUTERS — use in calculation of stream functions on isentropic surfaces, program for
ATMOSPHERIC PRECIPITATION — electrical charge of raindrop, design of instrument for measuring
DIFFUSION — equation for atmospheric, derivation of
PACIFIC OCEAN — fallout distribution in
NEUTRONS, FAST — effects on beryllium targets, analysis of
RADIATION DOSE — measurement in water-filled phantoms, neutron
RADIATION DOSIMETERS, PERSONNEL (PHOTOGRAPHIC FILM) — performance of, analysis of factors affecting
IRON-55 — content in body of man, use of gamma ray spectrometer for measurement of
COSMIC RADIATION — detection by gamma spectrometers, method for elimination of
MANUALS — preparation for use in radioisotope analysis in biological samples

38816 (CLM-R-73) A FARADAY Q-SWITCH. Gruber, J. E.; Spalding, I. J.; Ward, S. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Mar. 1967. 13p. Dep. CFSTI. UK 1s. 9d.

Electro- and magneto-optic Q-switches suitable for use with narrow line-width ruby lasers are briefly reviewed. Experiments on $\pi/2$ and $\pi/4$ Faraday-rotation Q-switches are described, and the operational convenience and merit of these switches is assessed. (auth)

38817 (COO-164-523) STUDIES IN MOLECULAR SPECTROSCOPY, MAY 1, 1965–DECEMBER 31, 1966. Edgell, Walter F. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). July 18, 1967. Contract AT(11-1)-164. 14p. Dep. CFSTI.

Research progress is reported on: vibration of alkali ions in solution, infrared band shapes, reaction of $Fe(CO)_5$ with amines, decomposition of $HMn(CO)_5$ following collision with an electron beam, vibration of larger molecules, and vibrational spectra of metal carbonyls and derivatives. (M.C.G.)

38818 (COO-1018-1094) ON THE APPLICATION AND DESIGN OF AN IMAGE STORE. Report No. 210. Ray, Sylvian R. (Illinois Univ., Urbana. Dept. of Computer Science). Aug. 22, 1966. Contract AT(11-1)-1018. 20p. Dep. CFSTI.

The value and use of an image store is discussed in the context of its application to an Information Resource Center: an information retrieval system incorporating a pattern-oriented general purpose computer and remote video communication network. With the proposed system configuration, text is stored only once — in low cost, high-introduction-rate image form. Indexing research, providing indexing in depth where required, and information reorganization may then proceed on a large scale without further recourse to external data handling. The use of a remote video communications net contributes a complication to the global system design which is rooted in channel capacity economics. In particular, the information content of stored images needs adjustment to match channel capacity, a problem which can be resolved by format control during original loading of the image store. Finally, two macrodesigns for image stores with different access times and storage capacities are sketched. (auth)

38819 (FOA-2-2480-51) KYLSYSTEM FOER KYLNING INOM KRYOGENA OMRADET MED SPECIELL TILLAEMPNING VID ELEKTRONISKA INSTRUMENT. (Cryogenic Temperature Systems for Electronic Instrument Application). Florin, G. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Apr. 1967. 15p. (In Swedish). Dep.

A survey is given on different processes and methods used as cryogenic heat sinks. Data and details on design and construction are summarized. (Sweden)

38820 (GEAP-5026) HIGH PURITY AUSTENITIC ALLOY FABRICATION PROCEDURES. Armijo, J. S.; Henderson, G. H.; Weber, J. E. (General Electric Co., Pleasanton, Calif. Nucleonics Lab.). June 1966. Contract AT(04-3)-189. 11p. (EURAEC-1790). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Techniques used in the preparation of high-purity 14% Cr–14% Ni–bal Fe alloys with various concentrations of specific impurities are described. The base alloy used in this study contained 500 ppM residual impurities. Impurities added included C, N_2, O_2, P, S, Si, and Mn. (auth)

38821 (IS-1631) HIGH TEMPERATURE FURNACE FOR THE PREPARATION OF LARGE SINGLE CRYSTALS. Gibson, E. D. (Ames Lab., Iowa). Aug. 1967. Contract W-7405-eng-82. 8p. Dep. CFSTI.

A high temperature furnace for the preparation of large single crystals is described. Included in the description are fabrication steps and schematics of the furnace and its power supply. A typical preparation procedure is presented. (auth)

38822 (K-L-6157) MODIFIED LIQUID CHROMATOGRAPHY MONITORING SYSTEM OPERATING AND MAINTENANCE MANUAL. Stevens, R. H.; Kermicle, H. A.; Smith, R. C. (comps.) (Oak Ridge Gaseous Diffusion Plant, Tenn.). July 5, 1967. Contract W-7405-eng-26. 33p. Dep. CFSTI.

This system will analyze a flowing stream for dissolved organic constituents and is specifically designed to monitor the effluent from liquid-liquid or liquid-solid chromatography columns. The complete monitoring system consists of a modified Barber-Colman Liquid Chromatography Monitor, Model 5400; a low-drift, feedback-type electrometer; and a Honeywell ElectroniK-19 recorder with an added autoranging circuit and event marker. The modifications and additions which were made to the monitor to improve the signal-to-noise ratio and increase the sensitivity and reproducibility are also listed. (C.E.S.)

38823 (LA-3400) AN EQUATION OF STATE FOR ADIPRENE FOAM AND ITS APPLICATION IN PRODUCING LOW PRESSURE-LONG TIME PULSES. Fritz, J. N.; Taylor, J. W. (Los Alamos Scientific Lab., N. Mex.). Sept. 20, 1965. Contract W-7405-eng-36. 79p. Dep. CFSTI.

The use of foams to produce low-amplitude–long-time pressure

pulses (hundreds of bars and millisecond durations) from the pulses ordinarily delivered by high explosives (hundred of kilobars and microsecond durations) is described. The general principle of using a light porous crushable medium to attenuate and prolong the pressure pulse from an explosive is well known. The problem is being able to design a system to produce a specified pressure pulse. An empirical theory is presented that works fairly well for at least one member of the family of light porous media, namely, foamed Adiprene rubber. A first approximation has been to treat porous media by the simple locking-solid model. Here, the primary feature of a porous solid, an asymptotic density, is incorporated in an equation of state by a derived adiabat in which one assumes an incompressible volume, with the remainder of the volume satisfying PV = constant. For the dynamic behavior, a linear shock velocity–particle velocity relation, in its essence an expression of the existence of an asymptotic density, is used. The sound speeds and asymptotic densities that fit the measured static and dynamic compressions agree, at least for Adiprene rubber foam. A complete E(P,V) relation is obtained by assuming a covolume law form for all adiabats intersecting the Hugoniot. A complete system involves loading the foam with sheet explosive. A complete hydrodynamic solution is not attempted for such a system, but plausible assumptions about the foam density are made, and overall integrals of the motion are related to the system, e.g., the explosive is treated by assuming it deposits an amount of linear momentum per unit area proportional to the explosive loading. Some experimental pressure profiles, measured by Kistler pressure transducers, are presented and compared with predictions. (auth)

38824 (LA-DC-8787) NET-2 EXTENSIONS AND DIFFERENCES WITH NET-1. Malmberg, Allan F. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 10p. (CONF-670630-1). Dep. CFSTI.

From SHARE Design Automation Conference, Los Angeles, Calif.

The general features of the NET-2 program are presented. This program under development on the MANIAC computer, will perform nonlinear DC and transient analysis and linearized AC analysis of arbitrary circuit configurations. The language for describing the circuit schematic is presented. Features for inclusion of models of various linear and nonlinear devices are discussed. The program is written so as to permit device models to be added without rewriting NET-2 itself. Models and their parameter values are stored in a model library and called into the calculation automatically. Input facilities are included for superseding library values of device parameters. A major feature of NET-2 is its variational capability. Three types of variational procedures are available: the STATE calculation which varies circuit parameters in discrete steps, the Monte Carlo calculation which determines the statistical distribution of response variables for a given circuit parameter population distribution, and the Extrema Search which extremizes the value of a response variable within an allowable circuit parameter space. (auth)

38825 (NASA-SP-135) METEOR ORBITS AND DUST. Proceedings of a Symposium held at Cambridge, Massachusetts, August 9–13, 1965. Smithsonian Contributions to Astrophysics, Volume 11. Hawkins, Gerald S. (ed.) (Smithsonian Astrophysical Observatory, Cambridge, Mass. National Aeronautics and Space Administration, Washington, D. C.). 1967. 412p. (CONF-650848). GPO $2.50.

Forty-five papers and four abstracts of papers are included. The following topics are covered: classification of orbits, observation equipment and methods, radio and radar observations, rocket and satellite studies of meteoric dust, dust in the stratosphere, and origin and chemical compositions of particles. (J.H.M.)

38826 (NP-16864) ATOMIC ENERGY BOARD TENTH ANNUAL REPORT, 1966. (Atomic Energy Board, Pretoria (South Africa)). 62p. Dep.

Research progress is reported on nuclear materials, nuclear power, application of radioisotopes and radiation, health and safety, fundamental studies, and technical activities. (M.C.G.)

38827 (NVO-1163-86) SIGNAL ANALYSIS USING AUTO- AND CROSS-CORRELATION TECHNIQUES AND ASSOCIATED PROCESSES. A FINAL REPORT ON A STATISTICAL APPROACH TO SEISMOGRAM ANALYSIS. Gorman, R. L. (Environmental Research Corp., Alexandria, Va.). [1967]. Contract AT(29-2)-1163. 55p. Dep. CFSTI.

The Fourier amplitude spectrum of a seismogram tends to have a somewhat erratic fine structure which can be smoothed, thereby facilitating its examination, by statistical techniques. The object of the study is to demonstrate the significance and optimization of window-smoothed Fourier amplitude-squared spectra (i.e., power spectra). This preliminary report condenses, unifies and extends those mathematical foundations of signal processing smoothing techniques, given in the references, which are pertinent to the prediction problem. The theory has been developed for stationary processes, though actual seismograms in practice are not stationary. However, the successful use of this theory, as for example in the nuclear detection problem (also a non-stationary process), suggests that it be investigated for applicability to the prediction problem. Also, the mathematics are presented from an abstract, operational point of view enabling a clarification of the statistical concepts with an indication of the usefulness of the stationary theory, even in the non-stationary case; e.g., the stability calculated for a given processing assuming stationary records will probably be less than the actual stability if this processing is used on non-stationary seismograms. The effects of smoothing of actual data are being studied, including the effects of variation in window shapes, window sizes and sample sizes. The theory has been extended to enable a direct processing of unsmoothed Fourier amplitude spectra and also to enable various coherence studies to be made in order to determine how closely different records relate to each other. (auth)

38828 (NYO-3747-2) SOME BALLOON TECHNIQUES. Hopper, V. D. (Melbourne Univ., Parkville (Australia)). June 15, 1967. Contract AT(30-1)-3747. 4p. (CONF-670602-24). Dep. CFSTI.

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif.

Three balloon devices and the techniques for using them are described. The devices are: a valve, a reel, and an all-sky camera. The valve permits the use of cheaper balloons and facilitates recovery of balloon-carried instruments. The reel is used in deploying equipment below a freely floating balloon and the camera is used to obtain photographs of the atmosphere including twilight effects using color film. (F.S.)

38829 (ORNL-3300(Vol.6)) PUBLICATIONS, REPORTS, AND PAPERS FOR 1966 FROM OAK RIDGE NATIONAL LABORATORY. O'Hara, F. M. Jr.; Klein, Ann S. (eds.) (Oak Ridge National Lab., Tenn.). Aug. 1967. Contract W-7405-eng-26. 365p. Dep. CFSTI.

A bibliography is presented of the publications, reports, and papers published in 1966 from Oak Ridge National Laboratory. Keyword and author indexes are also included. (B.G.D.)

38830 (ORNL-4137) A FORTRAN PROGRAM TO DRAW ISOMETRIC-TYPE PROJECTIONS WITH THE CALCOMP PLOTTER. Davis, Wallace Jr. (Oak Ridge National Lab., Tenn.). Aug. 1967. Contract W-7405-eng-26. 16p. Dep. CFSTI.

A FORTRAN program is described for drawing isometric and similar projections of curved lines and/or data points with the CALCOMP Digital Incremental Plotter. (auth)

38831 (ORNL-P-3074) PHYSICAL-CHEMICAL FACTORS UNDERLYING CELL INJURY IN CRYOSURGICAL FREEZING. Mazur, Peter (Oak Ridge National Lab., Tenn.). [1967]. Contract W-7405-eng-26. 32p. (CONF-670322-1). Dep. CFSTI.

From Symposium on Cryosurgery, Los Angeles, Calif.

Physico-chemical factors that underlie cellular injury at subzero temperatures are discussed. The effects of cooling rate, intracellular ice formation, and the warming rate on the survival of mammalian tissue cells; events in single cells and tissues during ice formation; methods for maximizing the effectiveness of cryosurgical freezing; and the sequence of events of cell survival in cryosurgical freezing are considered. It is concluded that the effectiveness of multiple freezing is difficult to predict and that the likelihood of killing all cells in a given target area could probably be increased by subjecting the target to two or more cycles of freezing to below −20°C and slow thawing. Schematic representations of events that occur in a supercooled cell or tissue sample are presented. (B.H.S.)

38832 (ORNL-TM-1830) MAJOR EVENTS OF THE NUCLEAR AGE: A CHRONOLOGY TO ASSIST IN THE ANALYSIS OF AMERICAN PUBLIC OPINION. Nordheim, Erik V.; Wilcox, Pamela B. (Oak Ridge National Lab., Tenn.). Aug. 1967. Contract W-7405-eng-26. 593p. Dep. CFSTI.

A chronology of major events of the nuclear age (1945-present) was compiled in order to test the nature of the interaction between different kinds of events and American security attitudes. An index of chronology is also presented. A foldout table of event categories, which is a summary of the event categories and their alphabetic referents, is included to help the analyst use the chronology and index. (B.G.D.)

38833 (ORNL-TM-1929) A SIMPLIFIED METHOD FOR MAKING PRELIMINARY THERMAL AND ECONOMIC ANALY-

SES OF VERTICAL-TUBE AND MULTISTAGE-FLASH MULTI-EFFECT EVAPORATOR PLANTS. Hise, E. C. (Oak Ridge National Lab., Tenn.). Aug. 1967. Contract W-7405-eng-26. 29p. (CONF-670807-2). Dep. CFSTI.

From 9th National Heat Transfer Conference, Seattle, Wash.

A simple method is presented for performing preliminary overall thermal and economic analyses of vertical tube and multistage-flash evaporator plants. The analyses are based on the terminal conditions of the plant and average values for heat transfer coefficients, boiling point elevations, and heats of vaporization. The method is not intended for effect-by-effect or stage-by-stage calculations. However, after the overall conditions have been established, the detailed calculations can be made with the same equations or by other means. Equations are developed for calculating performance ratio, heat requirements, surface area requirements, heat cost per unit product, and surface area cost per unit product. Equations are given for determining the optimum performance ratio for any given set of heat and surface area costs. (auth)

38834 (ORO-1637-13) THE ORIGIN AND FATE OF THIOCYANATE ION IN METABOLISM. Progress Report, April 30, 1965–April 30, 1967. Wood, John L. (Tennessee Univ., Memphis. Dept. of Biochemistry). Contract AT(40-1)-1637. 5p. Dep. CFSTI.

Progress was made in the study of the mechanisms by which thiocyanate arises endogenously, the chemical modifications that thiocyanate groups undergo in vivo, and the physiological implications of the chemical modifications. It was concluded that lactoperoxidase was active in producing conversion of thiocyanate to cyanide; on prolonged incubation in the presence of excess thiocyanate ion, the cyanide yield diminished. Sulfur dicyanide, $S(CN)_2$, was suggested as an intermediate product in the breakdown of thiocyanate. Sulfur dicyanide was acted upon by peroxidase and hydrogen peroxide to produce cyanide; however, in the presence of thiocyanate, cyanide production was diminished. The system was considered to be related to the system in erythrocytes that releases cyanide from thiocyanate. Horseradish peroxidase did not catalyze the breakdown of thiocyanate. Studies on thiocystine showed that it replaced cystine in the diet of the growing rat. Preliminary results showed that the compound also protected rats from an LD_{50} of cyanide. (B.H.S.)

38835 (RISO-M-512) PALIDELIGHEDSTEORI OG PLANLAEGNING AF PRAEVENTIV VEDLIGEHOLDELSE. (Reliability Theory and Planning of Preventive Maintenance). Timmermann, P. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jan. 1967. 23p. (In Danish). Dep.

The usual reliability concepts are introduced in order to discuss some ways of measuring the gain from preventive maintenance of electrical and mechanical equipment. (DENM)

38836 (RLO-1949-1) A STUDY OF THE RECENT CHANGES IN THE WASHINGTON TRI-CITIES ECONOMY: TRANSITION IN REVIEW. Archer, Stephen H.; Lenberg, Robert A. (Washington Univ., Seattle. Graduate School of Business Administration). Jan. 1966. Contract AT(45-1)-1949. 174p. Dep. CFSTI.

An investigation of various ways to arrest the decline of economic activity in the tri-cities (Kennewick, Pasco, and Richland, Washington) area due to the cutback in Atomic Energy Commission operations at Hanford is reported. The background of the contractual relations, the developments which occurred in anticipation of the cutback, the major developments which followed the announcement of the cutback, the efforts put forth to offset the impact, and various recommendations by other studies are discussed. The major conclusions and recommendations of the investigation are also presented. (B.G.D.)

38837 (SC-DC-66-2422) EXPERIMENTAL EARTH PENETRATION STUDIES. Colp, John L. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1966. Contract AT(29-1)-789. 40p. (CONF-670701-2). Dep. CFSTI.

From 3rd Pan-American Conference on Soil Mechanics and Foundation Engineering, Caracas, Venezuela.

A program of experimental investigations, both in the laboratory and in the field, to provide the information needed for an understanding of the problem of projectile penetration into earth materials is described. Two-dimensional laboratory penetration tests into a simulated granular cohesionless soil, bulked silt, dry sand, and a simulated cohesive incompressible soil, were performed. Three-dimensional laboratory penetration tests into water, dry sand, and pseudo-soils, were conducted. A series of field penetration tests into natural deposits of a dry lake playa and a clayey sand was made. A device to study the properties of several types of soil when simply sheared under dynamic loadings was developed and tested. (auth)

38838 (SC-DC-67-1922) THE FEASIBILITY OF RAPID SOIL INVESTIGATIONS USING HIGH-SPEED, EARTH-PENETRATING PROJECTILES. Caudle, W. N.; Pope, A. Y.; McNeill, R. L.; Margason, B. E. (Sandia Corp., Albuquerque, N. Mex.). [1967]. 23p. (CONF-670804-3). Dep. CFSTI.

From Symposium on Wave Propagation and Dynamic Properties of Earth Materials, Albuquerque, N. Mex.

A new method for remote and rapid soil investigations is described. Since 1962, about 700 full-scale earth penetrations have been accomplished using long, slender, instrumented projectiles dropped from aircraft. The projectiles contain accelerometers and other instruments, and they broadcast their decelerations during earth penetration through a long trailing antenna. The decelerations experienced by the projectile are used to estimate material properties. The entire determination is done from the air, and the resulting profile data identifies weak and strong soils, granular and cohesive soils, and layer interfaces including bedrock. The profile data are similar to those from a Standard Penetration Test, and can be used with about the same confidence. A penetrator system is described for rapidly determining profiles in remote or inaccessible areas on land or under water. (auth)

38839 (SC-R-67-1091) EXTENSION OF THE APPLICATION OF REPRODUCING KERNELS TO A SAMPLING THEOREM FOR ADAPTIVE SYSTEMS. Simmons, G. J. (Sandia Corp., Albuquerque, N. Mex.). June 1967. 12p. (CONF-670430-1). Dep. CFSTI.

From 19th Southwestern IEEE Conference, Dallas, Tex.

The method of reproducing kernels for the iterative approximation of functions f(Z) in E_n converges under weak assumptions. This theory is developed further and conditions on f(Z) for exact reconstruction by the kernel $K(Z, [nT]) = \prod_{k=1}^{n} [\sin(\pi/T_k)(z_k - n_k T_k)/(\pi/T_k)(z_k - n_k T_k)]$ are determined. The resulting sampling theorem does not require a knowledge of f(Z) but only a random sequence of argument-functional value pairs $\{f(Z_i), Z_i\}$. (auth)

38840 (SC-R-67-1096) ENVIRONMENTAL ENGINEERING ABSTRACTS. (Sandia Corp., Albuquerque, N. Mex.). Mar. 15, 1967. Contract AT(29-1)-789. 19p. Dep. CFSTI.

A bibliography is presented which contains 64 references to published literature on environmental engineering. (F.S.)

38841 (SC-R-67-1131) ALGEBRAIC THEORY OF THE TWO-SIDED CORRELATION FUNCTION FOR BINARY CODES. Simmons, G. J. (Sandia Corp., Albuquerque, N. Mex.). June 1967. Contract AT(29-1)-789. 28p. (SC-DC-67-1612; CONF-670902-1). Dep. CFSTI.

From International Symposium on Information Theory, Athens, Greece.

The algebraic properties of the two-sided correlation function are presented. The correlation operator is defined; algebraic characteristics are established in binary notation. The theory is directly applicable to problems where code choice is dependent on code correlation properties. (M.L.S.)

38842 (SC-R-67-1150) THE SANDIA HUMAN ERROR RATE BANK (SHERB). Rigby, Lynn V. (Sandia Corp., Albuquerque, N. Mex.). July 1967. Contract AT(29-1)-789. 20p. (CONF-670634-1). Dep. CFSTI.

From Symposium on Man-Machine Effectiveness Analysis Techniques and Data Requirements, Los Angeles, Calif.

For some years, Sandia has been deeply involved in the quantification of human performance, particularly in the development and use of estimates of human error to improve overall system reliability analysis. Recently, we have undertaken to consolidate the various estimates of human error into a single card file, to provide quick access to figures of interest at any particular moment. We call the figures we use "human error rates" (HER), and the file is called the "Sandia Human Error Rate Bank" (SHERB). The background for SHERB, the format and procedures employed in adding to and using SHERB, and some of the problems surmounted and lessons learned in the process are presented. (auth)

38843 (SC-RR-67-438) THE SANDIA CORPORATION RADIANT HEAT FACILITY. Adams, P. H.; Ault, R. L.; Barber, J. A.; Hartman, G. J.; Keltner, N. R. (Sandia Corp., Albuquerque, N. Mex.). Aug. 1967. 84p. Dep. CFSTI.

The capabilities and limitations of the Radiant Heat Facility are described. The two main types of testing equipment (quartz lamp and graphite resistor heater arrays), other specialized testing capabilities, data acquisition capabilities and instrumentation design, and the theory of radiation heat transfer are discussed. (auth)

38844 (SC-RR-67-462) SEQUENTIAL DECISION MODEL OF PLANETARY QUARANTINE PRIMARY OBJECTIVES. Trauth, C. A. Jr. (Sandia Corp., Albuquerque, N. Mex.). June 1967. Contract AT(29-1)-789. 46p. Dep. CFSTI.

There is apt to be much uncertainty in any program of planetary exploration. This uncertainty leads naturally to possible uncertainty in the time period in which planetary quarantine is desirable and to possible uncertainty in the total number of missions to be launched in the vicinity of any given planet. A model is developed in this report that makes possible the derivation of mission noncontamination requirements without a priori knowledge of either the time period in which planetary quarantine is to be observed or the total number of missions to be used in exploring the planet in question. (auth)

38845 (SC-RR-67-492) IMPROVED SONICATION METHOD FOR REMOVAL OF MICROORGANISMS FROM SURFACES. Oswalt, F. W.; McDade, J. J.; Franklin, C. M.; Dugan, V. L. (Sandia Corp., Albuquerque, N. Mex.). June 1967. Contract AT(29-1)-789. 22p. Dep. CFSTI.

Approaches, efforts, and results for improving the technique of removing microorganisms from stainless steel strip surfaces by use of ultrasonic cavitation are reported. Recommendations are made to enable others performing these operations to effect a more efficient removal in less time. (auth)

38846 (SC-RR-67-575) ELECTRONIC GENERATION OF QUADRATURES FOR SINUSOIDAL TRANSDUCERS. Campbell, J. W. (Sandia Corp., Albuquerque, N. Mex.). Aug. 1967. 62p. Dep. CFSTI.

The use of most transducers whose output is a sinusoidal function of the input has been limited due to the difficulty of resolving the ambiguity in their outputs. A technique is presented for electronically generating the quadrature information which resolves this output ambiguity. A mathematical model for this technique is developed, including practical considerations for implementation. Experimental confirmation of the technique is reported; this confirmation is supplied by resolving the ambiguity of the Laser Feedback Interferometer which heretofore was not possible. (auth)

38847 (SC-TM-64-1681) PROPOSED TIME-OF-DAY CLOCK UTILIZING DIGITAL MAGNETIC LOGIC. Braasch, R. H.; Howard, T. A. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1964. Contract AT(29-1)-789. 44p. Dep. CFSTI.

Several new techniques in the area of magnetic logic circuitry which can be applied to the development of a time-of-day clock. A complete description of the time-of-day clock is not undertaken. (auth)

38848 (SCL-CR-66-72) CARBORANE POLYBENZIMIDAZOLES. Sheratte, M. B. (Whittaker Corp., San Diego, Calif. Narmco Research and Development Div.). Apr. 1967. Contracts AT(29-1)-789; 18-0571. 29p. Dep. CFSTI.

For Sandia Corp., Livermore, Calif.

Two unsuccessful approaches were made to the preparation of polybenzimidazoles with a carborane or neo-carborane cage in the main chain. During the first attempt, neo-carborane-C,C′-dicarboxylic acid diphenyl ester was prepared, and an effort was made to condense this diester with tetraminobiphenyl under various conditions. All experiments conducted during this phase of the program failed, because it was found that the neo-carborane cage is more susceptible to nucleophilic attack than is the carbonyl carbon atom of the ester. This phase of the investigation was then abandoned, and an attempt was made to prepare 3,6-diphenylcarborane-C,C′-dicarboxylic acid, and to proceed to polymer from this acid. This acid was chosen because it is known that 3,6-diphenyl carborane is not susceptible to nucleophilic attack. However, attempts to dilithiate 3.6-diphenyl carborane led to only a mono-carboxylic acid under the conditions tried. (auth)

38849 (SCL-DR-67-52) ANALOG TAPE UNIT CONTROLLER. Colvin, H. A. (Sandia Corp., Livermore, Calif.). Aug. 1967. Contract AT(29-1)-789. 28p. Dep. CFSTI.

A tape unit controller which was incorporated in a signal processing system to eliminate the manual operation of the system's tape units is described. (auth)

38850 (UCID-15148) RHEOLOGY OF HIGH-EXPLOSIVE PASTES. General Chemistry Technical Note No. 254. Golopol, Hyman (California Univ., Livermore. Lawrence Radiation Lab.). May 18, 1967. Contract W-7405-eng-48. 26p. Dep. CFSTI.

Results of a study, now terminated, of the flow rates of high-explosive pastes composed of solids, liquids, polymers, and gels, through tubes and nozzles at pressures of 100 to 10,000 psi are summarized. (P.G.C.)

38851 (UCID-15177) METHOD OF QUARTZ CRYSTAL MALFUNCTION DETECTION FROM RECORDED OUTPUTS. Osborne, Robert L. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 22, 1966. Contract W-7405-eng-48. 10p. Dep. CFSTI.

The effects of a nonuniform pressure applied to the front face of a quartz crystal are shown. This was done by varying the diametral position of a pressure pulse applied to the front face of a quartz crystal and recording the voltage obtained across the signal and guard ring resistor. (R.C.M.)

38852 (UCID-15179) BOND INTEGRITY OF QUARTZ TRANSDUCER AND STRESS INPUT SPECIMEN BY ULTRASONICS. Osborne, Robert L. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 20, 1966. Contract W-7405-eng-48. 13p. Dep. CFSTI.

Ultrasonic bond inspection of sample material quartz transducer assemblies by the pulse echo technique is a practical method of detecting voids in the bonds. Minimum void area detectable depends on the skill of the operator but with reasonable care voids greater than $\frac{1}{16}$ in. dia should be consistently detectable. Of the various combinations of ultrasonic transducers tried, a 5 MHz, $\frac{3}{8}$ in. dia lithium sulfate transducer with a collimator was the most practical. Monitoring the quartz transducer output rather than the pulse echo did not give as accurate an indication of the void areas as the pulse echo technique but monitoring the quartz output can be used to check the continuity of the electrical connections on assembled quartz transducers. (auth)

38853 (UCRL-13302) CAPACITOR COST REDUCTION STUDY. (Maxwell Labs., Inc., San Diego, Calif.). July 31, 1967. Contract W-7405-eng-48. 19p. Dep. CFSTI.

For California Univ., Livermore, Lawrence Radiation Lab.

Data are presented on a capacitor cost reduction study which indicated that the cost per joule for the Maxwell Series H capacitor at its hi-pot voltage can be reduced from its present 6.7 cents per joule to 2.7 cents per joule. At the same time, the energy density can be increased from 6 joules/in.^{3} to 11. joules/in.^{3} with an increase in hi-pot voltage from 100 kV to 120 kV. The cost of testing and tooling to make the proposed changes is estimated to be an economic investment after the production of only two megajoules of capacitors. In addition, a significant advance in pulsed high-voltage technology will have been made. (auth)

38854 (UCRL-14754(Suppl.1)) TRUMP: A COMPUTER PROGRAM FOR TRANSIENT AND STEADY STATE TEMPERATURE DISTRIBUTIONS IN MULTIDIMENSIONAL SYSTEMS. Edwards, Arthur L. (California Univ., Livermore. Lawrence Radiation Lab.). June 16, 1967. Contract W-7405-eng-48. 18p. Dep. CFSTI.

A supplement to UCRL-14754, the TRUMP user's Manual, is presented. Its purpose is to bring users up to date on the status of the TRUMP code, procedures for its use under the Monitor and Octopus systems, other computer programs and subroutines useful in connection with TRUMP, special techniques for efficient problem solving with TRUMP, and definitions of input, internal, and output names used in TRUMP. (auth)

38855 (UCRL-17453) AN EPR STUDY OF THE $O_2(^1\Delta_g)$ MOLECULE. Falick, Arnold M. (California Univ., Berkeley. Lawrence Radiation Lab.). June 1967. Contract W-7405-eng-48. 83p. Dep. CFSTI.

Thesis.

The 4-line EPR spectrum of the J = 2 level of the $O_2(^1\Delta_g)$ molecule in discharged oxygen produced in a 13.56 MHz discharge-flow system was measured and analyzed. The calculated spectrum gives an excellent fit to the experimental one by using g_J = −0.66662. Transition matrix elements were calculated for the $O_2(^1\Delta_g)$ EPR transitions so that absolute concentration measurements could be made. The rate of the reaction $O_2(^1\Delta_g) + O_2(^1\Delta_g) \rightarrow 2\,O_2(^3\Sigma_g^-) + h\nu$ (6340 A) was measured as a function of pressure over range 0.1 to 1.0 torr and in mixtures of oxygen with up to 75% of He and Ar. The 6340 Å emission, which was detected with an interference filter and a photomultiplier, was found to be second order with respect to $O_2(^1\Delta_g)$ concentration under all of the experimental conditions used. The $O_2(^1\Delta_g)$ concentration was determined from the intensity of one of its EPR lines, and absolute concentrations were calculated by comparison with $O_2(^3\Sigma_g^-)$ ground-state EPR lines. The second-order rate constant for the reaction did not change with pressure or added gas and was found to be $k_1 = 5.0 \pm 0.5 \times 10^{-22}$ cm^3/molecule-sec, compared to the value of $k_1 = 2.3 \times 10^{-22}$ cm^3/molecule-sec obtained by Ogryzlo, et al. The results suggest that the reaction occurs via an O_4^* intermediate, which is simply a colliding pair of excited oxygen molecules. In addition it was found that $O_2(^1\Delta_g)$ is primarily formed in the discharge and that it reacts slowly or not at all with NO or NO_2. (auth)

38856 (UCRL-17545) HIGH-TEMPERATURE PHASE EQUILIBRIA IN THE LEAD TITANATE–LEAD ZIRCONATE SYSTEM. Moon, Ronald L. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1967. Contract W-7405-eng-48. 85p. Dep. CFSTI.

Thesis.

Phase relations at elevated temperatures in the lead titanate–

lead zirconate system were investigated by vapor loss, x-ray, thermal and differential thermal analyses. A solid solution is shown to exist in the region between the Curie and solidus temperatures. Experiments in the solid solution region conducted in vacuum at 1050 and 1100°C showed that vaporization of lead oxide results in the formation of a depletion layer at the sample's surface. The depletion layer is deficient in lead oxide and new phases appear as a consequence of this compositional change. The lowest temperature at which liquid is formed in this system, the melting point of lead titanate, was determined to be 1286 ± 3°C. Increasing the lead zirconate to lead titanate ratio increased the solidus temperature. The highest temperature, the melting point of lead zirconate, could be determined because of rapid crucible attack by the sample above 1500°C. At 1360°C a peritectic reaction occurs for compositions between 15 to approximately 40 mole % $PbZrO_3$. Above the peritectic temperature is a three phase region with liquid, zirconia and lead zirconate titanate solid solution in equilibrium. Compositions richer in $PbZrO_3$ than 40 mole % decompose directly to three phases at three phases at the solidus temperatures. The existence of the three phase region demonstrates that the lead titanate–lead zirconate system is not a true binary, but a subsection of the $PbO-TiO_2-ZrO_2$ ternary system. (auth)

38857 (UCRL–50256) SOLUTION DENSITIES OF SODIUM CHLORIDE AS A FUNCTION OF TEMPERATURE AND ANHYDROUS SALT CONTENT. Robison, William L.; Weston, Michael J. P. (California Univ., Livermore. Lawrence Radiation Lab.). May 4, 1967. 107p. Dep. CFSTI.

The International Critical Tables give the solution densities of sodium chloride as a function of anhydrous salt content at intervals of 2% and as a function of temperature at intervals of 10°C. A Lagrange polynomial generalized for two variables and requiring a double interpolation was used in conjunction with the data from these tables to generate tables with 0.1% intervals (from 1.00 to 20.90%) for anhydrous salt content and 0.1°C (from 0 to 36.3°C) for temperature. The density range is from $\rho = 1.00047$ to $\rho = 1.16405$. (auth)

38858 (UCRL–50269) EVALUATION OF THE THEORY OF CARCINOGENIC AROMATIC HYDROCARBONS. Hockensmith, Duane A. (California Univ., Livermore. Lawrence Radiation Lab.). May 17, 1967. Contract W-7405-eng-48. 26p. Dep. CFSTI.

Of the aromatic hydrocarbons reported to cause cancer in rats and other animals, one of the strongest carcinogens is 9,10-dimethylbenzanthracene, also called 7,12-dimethylbenz[α]anthracene or 7,12-DMBA. The theoretical explanation of the carcinogenic effect of this compound is discussed. Factors considered include the electronic properties of the carcinogen, the influence of steric factors, and the formation of charge transfer complexes. (C.H.)

38859 (UCRL–50285) INTERNATIONAL STATUS OF THERMAL ERROR RESEARCH. Bryan, James B. (California Univ., Livermore. Lawrence Radiation Lab.). July 3, 1967. 25p. (CONF-670901-3). Dep. CFSTI.

From CIRP International Conference on Manufacturing Technology, Ann Arbor, Mich.

A cooperative effort of the new CIRP Subgroup formed to deal with the overall problem of thermal effects errors in machine tools and metrology is described. The thermal effects problem is summarized by a diagram which is intended to show all possible forms of thermal error. Existing research literature and the need for new work is reviewed in terms of this diagram. (auth)

38860 (UUIP–528) DISLOCATION MOBILITY AND MULTIPLICATION DURING STRAIN AGEING OF IRON. Bergstroem, Y.; Vingsbo, O. (Uppsala Univ. (Sweden). Inst. of Physics). Apr. 1967. 25p. Dep.

A stress-strain relation was derived for ageing metals. The equation obtained describes the yield-drop phenomenon in terms of dislocation mobility and multiplication in good agreement with experimental stress-strain curves. The effect of strain ageing was introduced into the equation by describing dislocation locking in Cottrell atmospheres by Harper's equation. It was possible to express the increase in upper yield stress as a function of time, and the influence of total dislocation density, impurity content, and temperature was studied for Fe–N alloys. The suggested function describes the ageing process with respect to nitrogen in α-iron in agreement with experimental observations. An attempt was made to describe time-dependent ageing plateaus as the effect of two overlapping ageing processes of different velocities. It is finally suggested that the observed effect of increase in workhardening after strain ageing is the result of a precipitation-induced increase of the friction stress that opposes dislocation glide. (auth) (Sweden)

38861 (UUIP–529) CLEAVAGE IN INTRINSIC DISLOCATION DIPOLES IN CUBIC METALS. Vingsbo, Olof; Bergstroem, Yngve (Uppsala Univ. (Sweden). Inst. of Physics). Apr. 1967. 35p. Dep.

The process of cleavage in intrinsic dislocation dipoles was studied for cubic metals. Attention was paid to the anisotropy of cleavage strength, and several dipole geometries were investigated. An expression was derived for normal stress acting on the crystal planes in the dipole, and the cleavage process was suggested to be defined from stress relaxation. Cleavage conditions were derived and investigated with respect to stresses as well as energies. It was found that dipole cleavage is less probable than expected from earlier works. Dipoles of unit Burgers vector cleave only for pure edge orientation in the most brittle (Fe and W) of the investigated metals, and only if the distance between the dislocations is of the same order of magnitude as length of the Burgers vector up to $3d_0$ is a decrease of the influence of dipole orientation of the cleavage properties. (auth) (Sweden)

38862 (UUIP–542) STABILITY OF COUETTE FLOW. Herlitz, Sten (Uppsala Univ. (Sweden). Inst. of Physics). May 1967. 19p. Dep.

The stability of Couette flow between rotating cylinders is analyzed by means of the direct method of Lyapunov. Only rotationally symmetric perturbations are considered. The direct method is applicable to the nonlinear equations of motion and is not restricted to infinitesimal perturbations. The results derived include Rayleigh's circulation criterion for inviscid Couette flow and Synge's criterion for viscous flow. The case of a narrow gap between the cylinders is considered in some detail, and a stability criterion is obtained in close agreement with results previously derived on the assumption that the state of marginal stability is stationary. (auth)

38863 (UUIP–544) CONTROL SYSTEM FOR THE PLATE MOVEMENT OF A TELEVISION MICROSCOPE USED AS A PHOTOMETER. Berglund, Tord; Carlsson, Robert; Fahlman, Anders; Siegbahn, Kai (Uppsala Univ. (Sweden). Inst. of Physics). May 1967. 12p. Dep.

A control system for the plate movement of a new television microscope is reported. The plate is moved by two step motors and the movement is controlled electronically. This system makes the television microscope a very efficient photometer. The apparatus can also be used for other purposes, e.g., studies of dislocations. (auth)

38864 (WAPD-TM–657) MO552: A FORTRAN-4 PROGRAM FOR THE TIME DEPENDENT SOLUTION OF LINEAR ELASTIC SYSTEMS USING NORMAL MODE THEORY. Zanoni, E. A. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Mar. 1967. Contract AT(11-1)-Gen-14. 35p. Dep. CFSTI.

MO552 is a computer program utilizing Normal Mode theory that will compute the transient response of a linear-elastic, multi-mass system, having up to 50 lumped masses, when the foundation of the system undergoes a unidirectional velocity or acceleration transient. The foundation excitation can be input by specifying up to 2000 points of the transient taken at equal increments of time, or, up to 20 harmonic components may be specified to simulate a transient. Model damping coefficients may be specified. Transient stress, strain, or force can be computed at discrete locations within the system. The foundation transient may be plotted as output. (auth)

38865 (WAPD-TM–697) LARGE DEFLECTION THEORY FOR INELASTIC STRESSES AND STRAINS. Friedrich, Carl M. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Aug. 1967. Contract AT-11-1-GEN-14. 17p. Dep. CFSTI.

The large deflection theory for inelastic stresses and strains was derived by the use of vectors. The inelastic strain energy rate was obtained from the mechanical work rate of stresses on an infinitesimal free body. Relationships were developed that should help in the experimental-empirical determination of material properties. (auth)

38866 (Y–1586) IDENTIFICATION OF A NUMERICALLY CONTROLLED MACHINE TOOL SERVO LOOP. Miskell, R. V. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Aug. 21, 1967. Contract W-7405-eng-26. 73p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

A Pseudo Random Binary Sequence (PRBS) signal was used to obtain the closed loop transfer function of a precision continuous path numerically controlled (NC) machine tool/control system. The study substantiates the use of the PRBS as a means of determining the frequency response of NC machines, and justifies further investigation into the use of the PRBS in the identification element of an adaptive control system. (auth)

38867 (JPRS-41149) VESTNIK OF THE USSR ACADEMY OF MEDICAL SCIENCES, NO. 4, APRIL 1967. Translation of Vestn. Akad. Med. Nauk SSSR, 22: No. 4, 1-96(Apr. 1967). 153p. (TT-67-31790). CFSTI.

Fourteen papers are presented. A separate abstract has been prepared for one of the papers. (W.E.B.)

For an abstract of the individual paper see: 36623.

38868 ANNALS OF RELIABILITY AND MAINTAINABILITY. VOLUME 4. PRACTICAL TECHNIQUES AND APPLICATION. Fourth Annual Reliability and Maintainability Conference, 28-30 July 1965, Los Angeles. Coutinho, John de S. (ed.). Washington, D. C., Spartan Books Inc., 1965. 945p. $19.50. (CONF-650719).

An abstract was prepared for one paper selected from those presented at the conference. Other papers presented were concerned with program management, specifications, systems safety, human factors, reliability, materials properties, maintenance, fabrication, testing and data feedback. (J.R.D.)

For an abstract of the individual paper see: 36307.

38869 NEITRONY V RADIOBIOLOGICHESKOM EKSPERIMENTE. (Neutrons in Radiobiological Experiments). Isaev, B. M.; Bregadze, Yu. I. Moscow, Izdatel'stvo Nauka, 1967. 292p.

Radiobiological studies using various energy neutrons produced by radioisotopes, accelerators, and reactors are described. The initial physical mechanisms of neutron interactions with biological objects, methods for measuring and evaluating absorbed doses, and some devices used in the investigation of neutron effects are discussed. Interactions of heavy particles and electrons with biological tissues, experiments with thermal and fast neutrons, spectra of linear energy losses, and relative biological efficiency are also discussed. Bibliographies (24 references) are included. (R.V.J.)